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VOL. 27 JUNE, 1934 No. 3

Proceedings of the Forty-Sixth Annual Meeting of the American Association of Economic Entomologists

Section of Plant Quarantine and Inspection

Wednesday Afternoon Session, December 27, 1933

The meeting of the Section of Plant Quarantine and Inspection of the American Association of Economic Entomologists convened at 1:30 p. m. in Parlor A at the Hotel Bradford, Boston. In the absence of Dr. R. W. Leiby, Chairman of the Section, Mr. C. H. Hadley presided.

The acting chairman appointed the following committees:

Resolutions: L. A. Stearns and J. S. Houser.

Nominations: L. S. McLaine, Ray Hutson and C. A. Weigel.

OUTBREAK OF AN AFRICAN MOTH IN STORED SENNA

By HARRY B. WEISS and EDGAR G. REX, *Trenton, N. J.*

On September 28, 1933, word was received by the New Jersey Department of Agriculture from the Bureau of Plant Quarantine, United States Department of Agriculture, that some 30 carloads of senna leaves stored in a warehouse at Hoboken, N. J., were infested by a moth belonging to the African genus Tortilia Chetcn., a member of the family Heliodinidae. Conditions at the warehouse at this time showed heavy infestations in some bales, hundreds of moths being found on and around the bales, together with numerous cocoons, containing larvae and pupae, on the burlap and in the senna leaves to a depth of several inches. For the most part, the injured leaves were confined to the outer four or five inches of the bales.

[1]Dr. Busck will describe it as a new species of Tortilia and the description, with illustration, will appear in the Proceedings of the Washington Entomological Society in 1934.

Dr. August Busck, who identified the species[1] as belonging to the genus Tortilia, stated that this genus was known from a single Algerian species, *T. flavella* Chr. He also reported that other species in closely related genera feed on dry vegetable matter, but that none had been reported as economically injurious.

The senna leaves at Hoboken had been in storage from one and a half to three years, and were said to have originated in Sudan, Africa. Some of the bales contained Indian senna, and some of the recent consignments (136 bales) of this to New York City were examined by inspectors of the Bureau of Plant Quarantine, but no evidence of moths was found. The Indian senna was in compressed bales as contrasted with the African senna which was in uncompressed bales.

In view of the damage being done at Hoboken and because of the possibility that the insect might prove to be a serious pest of stored products, if allowed to become established in the country, the New Jersey Department of Agriculture on September 28, 1933, issued an order placing the senna in quarantine, until it had been satisfactorily fumigated with hydrocyanic acid gas.

After numerous conferences with the warehouse authorities and the New York City owners of the senna, the use of Carboxide, a mixture of ethylene oxide and carbon dioxide, was permitted, and on November 17, 1933, the material was fumigated, at the expense of the owners.

The some 2,300 bales, weighing about 645,000 pounds and occupying space equivalent to over 30 carloads, were placed in two large rooms of the warehouse, one of 152,000 cubic feet and the other of 141,000 cubic feet.

The Carboxide was used at a rate slightly over 15 pounds to each 1,000 cubic feet. For the total of 293,000 cubic feet, 75 tanks, each containing 60 pounds of Carboxide, were used. The length of exposure was 48 hours. The temperature of the rooms ranged between 52 and 60° F.

At the time of fumigation, practically all the moths had disappeared. However, a few eggs and larvae were found. In order to determine the effectiveness and penetration of the gas, pill boxes and vials containing other species of live insects were placed between and inside the bales. At the end of the fumigation, these insects were all dead and the insects in the check vials were alive. Ethylene oxide is known to have considerable toxicity to the eggs of insects, and it is believed that on the whole, the fumigation was successful.

THE NEW SOIL DISINFECTANT EMPLOYED IN POTATO WART ERADICATION IN PENNSYLVANIA

By R. E. HARTMAN, *Hazleton, Pa.*

(Withdrawn for publication elsewhere)

INSECT FINDINGS OF RECENT YEARS WHICH ARE OR MAY BECOME OF INTEREST TO NURSERY INSPECTORS AND PLANT QUARANTINE OFFICERS

By J. A. HYSLOP, *Senior Entomologist, Bureau of Entomology*

In reviewing the Insect Pest Survey records covering the past few years, I was impressed by the large number of unfamiliar names. Some of these are of foreign pests newly recorded in our fauna; others are of recently described native insects heretofore unknown; and still others are of insects long known to our fauna, but considered as of no economic importance, that have recently assumed new and destructive habits. Finally there are those recognized pests of one part of the country that have recently appeared in other parts.

Believing that these records would be of particular interest to the workers in the regulatory field, I have prepared a brief summary of a number of these insects. The dates are the years in which we received reports of these insects and should not be considered as the dates of possible introduction, as we have no evidence as to when they were introduced. Several years may elapse after introduction before an insect becomes of sufficient importance to be observed.

Tholeria reversalis Guenée (Spec. Gen., V. 8, p. 409), a noctuid moth, has been known for many years and is widely distributed in the United States. The larvae were found on *Sophora tomentosa* in Florida in 1890 and 1900, and were recorded from *Genista* and *Cytisus* in greenhouses in New York in 1896. In 1931, serious infestations on *Genista* were reported from southern California, complete defoliation having occurred in many places; similar defoliation occurred in 1932. It also attacks *Buddleia* and *Lagerstroemia*.

Gnorimoschema lycopersicella Busck, a gelechiid, was described (Proc. Hawaiian Ent. Soc. 1927 *7*: 171, June 1928) from material collected and reared from tomato in Oahu, Hawaiian Islands, and Sinaloa, Mexico, and California. Busck believed it to be introduced into Hawaii, but O. H. Swezey found it there on wild as well as cultivated tomatoes. The

species was also found in material reared from tomato leaves in 1925 and 1926 in Mexico and southern California. According to Busck this is the species referred to in earlier Californian publications under the name *G. glochinella*. In southern California it is a serious pest of tomato fruit. In 1931 it was found seriously damaging tomatoes under glass and was found in the field near greenhouses on tomatoes in Pennsylvania; in 1932 it was found in Florida; and in 1933 in a greenhouse at Norfolk, Va.

Chrysoclista linneella Clerck, an European cosmopterygid moth, was first discovered in the United States near New York City in 1928. The larvae bore in the woody parts of the linden tree. We have received no further records.

Epinotia subviridis Heinrich, an olethreutid, was first collected in 1928, when a specimen was sent to the National Museum from Berkeley, Calif., where it was webbing and destroying cypress foliage. It was described by Heinrich in 1929 (Proc. U. S. Nat. Mus. 75: 15) and since that time it has been found attacking cypress in many parts of California, Washington, and British Columbia.

Eucosma gloriola Heinrich was described (Proc. Ent. Soc. Wash. 33 (8): 196. 1931) from material collected in tips of white pine at Stamford, Conn., in 1930 and from which adults emerged in 1931. This pine tip moth was generally abundant in the lateral shoots of white pine at Stamford in 1930 and reported from other localities in Connecticut. In 1933 it was found to be well established in Westchester County, New York. It is sufficiently numerous to cause appreciable injury.

Tortrix ivana Fernald was described (Jour. N. Y. Ent. Soc. 9: 49) in 1901 from Florida, where it was attacking *Iva imbricata*. It had not been recorded since that date until 1931, when it severely damaged foliage and flower buds of roses on Long Island, New York. It has not been reported since 1931.

Cacoecia conflictana Walker, a tortricid leaf roller, previously known in our fauna and recorded on aspen in Canada for many years, became destructively abundant in the United States for the first time in 1931, when it defoliated about 43,000 acres of poplar in Maine.

Platynota stultana Walsingham, a tortricid leaf tier, was described (Trans. Ent. Soc. Lond. 1884: 127–128) from Sonora, Mexico. It has also been known to occur in southern California for several years. In 1933 it was found damaging the new growth on about 15 per cent of the plants in a 100,000-rose greenhouse in Alexandria, Va. In Mexico and California it is recorded as attacking cherimoya, red pepper, bell pepper,

tomato, grapefruit, orange, cotton, walnut, avocado, and several other plants.

Batodes angustiorana Haworth, a European lepidopteron, attacking yew (*Taxus* spp.) and occasionally oak, grape, and rhododendron, was first recorded on this continent in 1928, when it was discovered in the gardens of the Parliament buildings in Victoria B. C., where it was seriously damaging pyramidal yews. It suffered serious mortality in the winter of 1929–30 and only small numbers were observed in 1930 and 1931. It was not reported in 1932 or 1933.

Ablabia longana Haworth, an European tortricid, was first recorded in the United States in 1929, when it was found damaging strawberry crowns in the Willamette Valley of Oregon and the flower buds of bulbous iris near Portland. In Oregon and Washington it has developed into a serious enemy of strawberries and is recorded from a number of other plants, including, rose, blackberry, and flax.

Coleophora salmani Heinrich, a case-bearing lepidopteron, was described (Proc. Ent. Soc. Wash. 31 (1): 18. 1929) from material collected on birch at Mt. Desert Island, Maine, in 1928. Since then it has been found at many places in southern Maine and at one place in west-central New Hampshire. Severe skeletonizing occurs and attacked trees appear as though scorched by fire.

Nepticula sericopeza Zeller, a European moth, was first observed in this country in 1928, when it was found mining the leaf petioles of Norway maple. In 1930 it was found mining in seed-stems of Norway maple and by that time was known to occur throughout New England, New York, New Jersey, and into eastern Pennsylvania.

Heteroderes laurentii Guerin, a South American elaterid, was first found in 1927 in southern Alabama, where the larvae were attacking sweet-potato and Irish potato tubers. A survey in 1930 indicated that it was well distributed in the Gulf coast section of Mississippi, Alabama, and western Florida. In 1932 specimens were collected near Charleston, S. C. In Alabama and Mississippi considerable damage has been done to potatoes; and it is also known to feed on corn seed and turnips.

Chrysobothris fragariae Fisher, a buprestid, was described in 1930 (Proc. Ent. Soc. Wash. 32 (8): 149). It was found boring in the crowns of strawberry plants in Washington and Idaho in 1928. It is also believed to occur in Oregon and California.

Crypticus obsoletus (Say) is a native eastern tenebrionid beetle that has been known since 1823. It was first recorded as a pest by M. M.

High in 1932, when he found it damaging immature fruit of strawberries in Mississippi. Fully 90 per cent of the fruit at one place was destroyed.

Ptinus tectus Boieldieu, a beetle, described from Tasmania (Ann. Soc. Ent. France 4:652 (552 by typographical error) 1856), is widely distributed in Europe, where it attacks stored products, including dried milk, cereals, chocolate, pepper, fish meal, fertilizer, and woolen carpets. The first record on this continent was made in the winter of 1931–32 at Vancouver, B. C., and later that year it was found in stored fish meal in California and in imported fertilizer in Washington.

Bruchus brachialis Fahraeus was collected in large numbers in a patch of vetch at Haddon Heights, N. J., in June 1931. Later that year this weevil was found in several localities in New Jersey and in Delaware and on the Eastern Shore of Maryland. It is one of the important vetch-seed weevils of Europe and Asia Minor.

Brachyrhinus cribricollis Gyllenhall was found for the first time on this continent in 1928, when the weevil was collected from a wide variety of ornamental plants and trees in southern California, doing particular damage to privet and pittosporum. The larvae feed in the finer roots and the adults attack the leaves and tender twigs. Later surveys indicated that it was distributed as far north as the San Francisco Bay district. This insect has been known for over 20 years as a pest of deciduous and citrus fruit trees in Australia and is recorded as a pest of eucalyptus in Spain and olive in Algeria.

Brachyrhinus ligustici Linnaeus is a well known weevil that attacks a wide variety of plants throughout Europe and the Near East. The larvae feed on roots and the adults feed on buds and leaves. In Europe it is known to feed on alfalfa, turnip, asparagus, clover, sugar beet, grape, peach and strawberry. It was first recorded in North America in 1933, when specimens were collected on newly-set raspberry plants at Oswego, N. Y.

Sitona cylindricollis Fahraeus is an European weevil known to attack sweetclover. It was first recorded on this continent in 1933 at Middlebury, Vt., where it so severely injured young sweetclover as to necessitate replanting. It was also found on the New York side of the Lake Champlain Valley, and at Storrs, Conn., and Amherst, Mass., according to notes received by the Survey.

Listroderes obliquus Gyllenhall, the vegetable weevil, was first discovered in the United States in southern Mississippi in 1922. It is apparently a South American species and is known to attack practically all vegetables and many flower-garden plants. It is now known to

occur from eastern Texas across Louisiana and the southeastern corner of Arkansas to the western corner of South Carolina and southward to the Gulf, including western Florida and is also found in California.

Trichalophus didymus Le Conte, a curculionid, was described (Proc. Acad. Nat. Sci. Phila. 7: 20. 1854) from Oregon. It was unknown as a crop pest until 1931, when it was reported as slightly damaging strawberries at Tacoma, Wash. Prior to this it was stated that it was known as a strawberry pest on Whidby Island, Wash.

Anacentrinus subnudus Buchanan has been recognized for several years as a minor pest of sugarcane in Louisiana, the larvae of the weevil boring into and destroying the eyes and new growth of cane and sometimes being responsible for poor stands. It was first recorded by Van Dine from Berwick, La., in 1910 and by Holloway at New Orleans in 1912, and it has been recorded several times since in various places in Louisiana. It was first technically described and named by Buchanan (Ann. Ent. Soc. Amer. 25: 328. 1932).

Pseudocneorrhinus setosus Roelofs, a Japanese weevil, was first recorded in this country at New Haven, Conn., in 1920, where it was found feeding on a weed, bur marigold. It had been collected, however, in 1914 at Riverton, N. J., as evidenced by specimens in the National Museum. It attracted no more attention until 1931, when it was found feeding on Japanese barberry, California privet, lilac, and hemlock at West Haven, Conn. The privet and barberry hedges were stripped of foliage. In 1932 and 1933 it reappeared in both New Haven and West Haven, even more severely stripping plants than in the two previous years, and adding forsythia, weigelia, and mountain laurel to its food plants.

Tychius picirostris Fab. is a well known European clover weevil feeding in the seed capsules of red clover and on plantain and *Genista*. It was first recorded from the Pacific Coast in 1930, when specimens were swept from clover heads at Puyallup, Wash.

Ceutorhynchus tau Le Conte (Proc. Amer. Phil. Soc. 15: 278. 1876), a native weevil, was unknown as a pest up to 1932, when it was recorded as damaging seedling onions near Corpus Christi, Tex., the larvae feeding on the bases of the leaves. One 50-acre field was so severely damaged that it was plowed under. Garlic was even more severely damaged than onion.

Cryptococcus fagi Baerensprung, the beech scale, which is an European pest, was discovered in the Maritime Provinces of Canada several years

ago. It is associated with a beech disease produced by a fungus, *Nectria* sp. In 1931 it was first discovered in the United States and is now widespread in Maine and eastern Massachusetts and is attracting considerable attention.

Aleurodicus cardini Back, Cardin's whitefly, was described in 1912 (Can. Ent. 44: 148) from material collected in Cuba on guava in 1910. In 1921 the species was collected in Miami, Fla., on the same plant; and since that date it has been found in several localities in Florida damaging guava bushes.

Phenacoccus gossypii Townsend and Cockerell, the Mexican mealybug, has been known for many years in California. It was at first misdetermined as *P. colemani* Ehrhorn. Within the last few years it has developed as a serious greenhouse pest throughout the East, having been reported from Florida, Indiana, Illinois, Maryland, Michigan, Mississippi, New York, Ohio, and Virginia, particularly on chrysanthemum. It is also known to attack a wide variety of ornamentals and citrus, cotton, tomato, eggplant, pepper and okra.

Tibicen davisi Smith and Grosbeck was described in 1907 (Ent. News 18: 127) from material from New Jersey. It is recorded from New York, Georgia, Florida, New Jersey, Mississippi, Arkansas, and North Carolina but was not known to be of any economic importance. In 1930 it was found to be seriously infesting fern asparagus in large ferneries in Florida, the nymphs feeding on the roots of the asparagus plants in the nurseries.

Cyrtopeltis geniculata Fieber, a North American mirid, is recorded from Florida to Texas, Arizona, and southern California. It also occurs in Mexico, Brazil, Puerto Rico, and Hawaii. It was first found in Hawaii in 1924 by O. H. Swezey, who collected it on tomato vines. In 1929 J. F. Illingworth said that it was the most serious pest of this crop in Hawaii. In the United States it was not reported as a crop pest until 1931, when several growers and shippers in Orange County, California, found it seriously damaging tomatoes.

Pangaeus uhleri Signoret (*P. rugifrons* Uhler) is an heteropteron known to occur in North Carolina, South Carolina, Georgia, and Texas. In 1930 this insect was first recorded as a pest. It was found eating out newly sprouted spinach seedlings before they emerged from the ground in the Norfolk trucking district, necessitating in one case the reseeding of 43 acres.

Dasyneura mali Kieffer was first recorded in this country in 1932, when it was found established at Ipswich, Mass. There is evidence that

it was present in 1929. It is an apple leaf-curling midge, well known in Europe.

Dasyneura pyri Bouché, the pear leaf-curling midge, an European insect reported to be very destructive in young pear orchards, was first observed in this country in Ulster County, New York, in 1931. It was found in Dutchess County, New York, in 1933.

Diprion polytomum Hartig, a well known European spruce sawfly, was found to be well established on the Gaspé Peninsula of Quebec, Canada, in 1930, in which year it defoliated 15 acres of spruce, and by 1932 the entire peninsula was heavily infested and bark beetles were working on defoliated trees, killing many. In 1932 it was reported for the first time in the United States, at Bar Harbor, Me.

Susana cupressi Rohwer and Middleton (Proc. Ent. Soc. Wash. 34: 94. 1932), a sawfly, was described from material reared from Monterey cypress in California in 1931. It was reported in 1932 as damaging foliage of Arizona cypress and Monterey cypress, and in 1933 it again made its appearance. Although rendering the plants unsightly, it is as yet of minor importance.

Taeniothrips atratus montanus Priessner is a variety of the common European thrips *T. atratus* Haliday. In Europe the variety is apparently confined to the Balkans and Austria and is not nearly so common as typical *atratus*. In 1931 it was found on gladiolus in Massachusetts and New Jersey, the first record of the variety in this country. It has a wide variety of food plants.

Taeniothrips gladioli Moulton and Steinweden, the gladiolus thrips, was described in 1931 (Can. Ent. 63 (1): 20) from material collected on gladiolus in Ontario, Canada, and Cleveland, Ohio. Severe injury was occasioned that year by the gladiolus thrips in many localities in the Eastern States. The insect has been collected from a wide variety of plants and is now known to occur throughout practically the entire United States and Canada wherever gladiolus is grown.

Bregmatothrips iridis Watson, a thrips attacking various plants, particularly torchlily and Japanese iris, was first found to be established in the United States at Hamburg, N. Y., in 1931. In 1932 it was found at Sterlington, N. Y. It has frequently been intercepted on iris imported from Holland, England, and France at the ports of entry.

Daihinia brevipes Haldeman, a native camel cricket of our Western States, was reported as seriously damaging garden and truck crops at Hollis, Okla., in 1932. In 1933 it appeared again in that locality.

Eriophyes avellanae Nalepa, a European bud mite of the hazelnut or

filbert, has been known as a serious pest of these nuts in Washington and Oregon for many years. In 1929 it was found attacking filberts at Stamford, Conn. The infested buds develop to twice natural size, fail to develop seed, and finally wither and drop off.

Although most of these insects are of very minor importance, a few have already assumed destructive proportions; and in the future literature of economic entomology many of these names will undoubtedly be common.

DEVELOPMENTS IN BULB PEST CONTROL WITH SPECIAL REFERENCE TO LILY THRIPS, GLADIOLUS THRIPS, AND NARCISSUS FLIES

By C. A. Weigel, *Washington, D. C.*

(Withdrawn for publication elsewhere)

THE EUROPEAN EARWIG AS A PEST IN RHODE ISLAND

By A. E. Stene, Providence, *R. I.*

The European earwig (*Forficula auricularia*) first attracted notice as a pest in Newport in 1911. In 1912 specimens were sent to my office at Kingston and to the Department of Agriculture at Washington. Four years later the insect was carefully studied by D. W. Jones of the U. S. Department of Agriculture and the results of his studies as well as of a survey to determine distribution was published in Bulletin No. 566 of the U. S. Department of Agriculture. At that time the insect was looked upon as a serious depredator in gardens and as a household pest in many sections of the City of Newport, but although specimens were found as far north as the southern part of Portsmouth it had attracted practically no attention outside of the city. At the present time it is abundant and probably more widely distributed in Newport and it can be fairly readily found in all parts of the island of Newport, the southern end of Jamestown and on the east side of the Seaconnet River through Tiverton and Little Compton, although from the latter town no calls for bait were made up to the last year of the State Department's distribution of bait. A few specimens have been picked up in Providence and in Fall River, but so far the insect has not appeared in sufficient numbers outside of Newport County to arouse public apprehension necessary to stimulate property owners to make complaint or even send specimens to the State Department of Agriculture as is

frequently done when some insect pest becomes abundant enough to attract attention.

The State Department of Agriculture for six years, from 1925 to 1931, inclusive, conducted a campaign for the suppression of the insect in cooperation with local organizations and property owners in Newport County, and established stations for the distribution of bait. From 1925 to 1928 these stations were located entirely on the island of Rhode Island. In 1929 requests for bait were received from Jamestown in sufficient numbers so that a station was established there and in 1930 Tiverton was added to the list. The amount of bait distributed was increased from 12¾ tons the first year to 15½ tons in 1931. During the first two years nearly all of this was used in the city of Newport and even during the last year 27,000 lbs. (13½ tons) of the 15½ tons were used in this same location. This would indicate that although the insect has spread slowly, it has not yet appeared in sufficient numbers outside of Newport to stir property owners into widespread and aggressive action in securing bait and distributing it.

In the neighborhood of Newport are a number of quite large nurseries where an infestation of the earwig might readily be established. The nurserymen, however, have been among the most active in combating the insect and have used the bait recommended and in some cases have sprayed and trapped as well. Some years ago in a conference with the nurserymen we suggested to them that they endeavor to segregate all plants attractive as food to the earwig and especially to keep such plants from the vicinity of fields containing evergreens and other nursery stock usually sent out with balled and burlaped roots. Nurserymen have also been urged to use every precaution in handling of packing material in order to prevent possible distribution of the insect through this channel. Many of the nurserymen have had experience with the earwig while living in foreign countries and it has been difficult for them, based on this earlier experience, to sense any great danger from its presence. They have realized, however, that distribution of the earwig in their stock would lay them open to criticism and perhaps reduction of orders from any buyers of nursery stock who should find the insect among their purchases. That these measures of preventing spread have been of some help is perhaps indicated by our experience so far in Rhode Island, for although the insect has been present in some of the nurseries near Newport in small numbers for several years, it has not been discovered in any of the nurseries outside of Newport County. This condition exists in spite of the fact that a great many of the small retail nurseries in

other parts of the state are buying fairly large quantities of stock from the wholesale nurseries near Newport. At the present time we surmise that danger of spread is probably greater from fruits and vegetables than from nursery stock. Examination of such articles at roadside stands and also in the Newport markets have frequently led to the discovery of earwigs.

The history of the earwig in Newport Co. naturally raises a question, however, as to whether, in view of the relatively slow spread there as compared with the colony on the Pacific coast, the climate is entirely suitable to the insect. It is not unlikely that enough insects to start new colonies in other parts of the state have been carried out of the infested area on various kinds of products but if so, they have failed to establish new centers at a distance from the original location. Possibly the somewhat milder weather of the Newport area and other places near the ocean present the only favorable condition for their propagation and maintenance in the state. A similar retarded spread is apparently taking place with a colony discovered in Aurora, New York,—near Buffalo—in 1912. According to a statement by Dr. Felt in the Economic Entomologist for 1927 or 15 years after its discovery, the insect had then "become generally established through the residential area of the village without, however, having occasioned severe injury or annoyance and apparently so far as this information indicates, without spreading into other localities to a noticeable extent."

It is the feeling among residents of Newport County and among nurserymen and growers of all kinds of plants that while the insect is a serious nuisance in residential districts and more or less of a pest of flowers and vegetables, it is one that can be quite readily controlled by proper methods. The greatest difficulty lies in getting concerted effort among all residents in a given infested locality. In a test conducted by the State Department of Agriculture some years ago it was found that in an area in which employees of the Department supplemented work of cooperating property owners by spreading bait in vacant lots or on property of absentee owners or non-cooperators, it was readily possible to satisfactorily reduce relatively heavy infestations, not only for the current season but quite effectively also for the following season, as compared with results in areas where the work was less thorough.

The insect apparently has its ups and downs, being more abundant some years than others. Housekeepers generally can control them, when not too abundant, by trapping and by contact sprays and in seasons of greater abundance they can be effectively reduced in numbers by the

distribution of bait in the proper manner. In the farming localities it has been so far a relatively unimportant pest, although, as already stated, in the agricultural districts adjoining Newport, it is not difficult to find specimens during almost any season.

THE NEW OUTBREAK OF THE DUTCH ELM DISEASE

By R. KENT BEATTIE, *Principal Pathologist, Forest Pathology, Bureau of Plant Industry*

In 1930 the Dutch Elm Disease was discovered in the United States. Three infected trees were found in Cleveland and one in Cincinnati, Ohio. In 1931 four trees were located in Cleveland. In 1932 no trees were found. The infection was exterminated, the elms of the region were carefully scrutinized, and an effort was made to stimulate pathologists, shade-tree men, and tree lovers everywhere to watch for the disease.

Toward the end of June, 1933, the disease was discovered in Maplewood, N. J. Little money was available with which to conduct a campaign but with the best of cooperation from State and local forces the work was organized and an effort was made to determine the extent of the infection, to discover the individual infected trees, and to remove and burn them.

The location of this infection so near to New York City, the greatest port of arrival in the United States for foreign merchandise, indicated this new outbreak was in some way connected with importations through that port. No immediate connection could be traced to the previously-known Ohio infections.

This puzzling and utterly unintelligible situation was clarified when beginning early in August elm logs from Europe were intercepted at the ports of Baltimore, Norfolk, New York, and New Orleans by the inspectors of the Bureau of Plant Quarantine. Cultures were made immediately from many of these logs and *Graphium ulmi*, the causal fungus of the Dutch Elm disease, was isolated from two shipments of logs at Baltimore, two at New York, one at Norfolk, and one at New Orleans.

Quarantine No. 70 promulgated by the Secretary of Agriculture, effective October 21, 1933, so restricts the further importation of these logs as it is believed, to safeguard them in the future.

In all of these shipments of logs elm bark beetles were also found. A part of these were determined by Dr. M. W. Blackman of the Bureau of Entomology as *Scolytus scolytus* and a part as *Scolytus multistriatus*. The former is considered by European investigators to be the principal

carrier of *Graphium ulmi* in Europe. It has not yet been found established in the United States. The latter which is also a carrier in Europe, has been known in eastern Massachusetts for about 30 years. It also occurs in Connecticut, New York, New Jersey, and Pennsylvania. It is not known to occur in Ohio.

The logs above-mentioned were elm burls from France. They were imported for the purpose of being cut into fancy veneer and were destined for veneer mills mostly in the interior of the United States. Further investigation has shown that the importation of such logs has occurred in recent years only. No records have been found yet of importations made prior to 1927. Such importations have been made from France, Germany, and England. It is possible that the earlier logs came from places in Europe, to which the Dutch elm disease had not then penetrated and that, therefore, they did not carry the disease. However the disease has now spread so widely over Europe that the recently imported logs are generally infected.

Of the 250 or more veneer factories in the country less than a dozen have imported foreign elm. Such factories are known to be located in Indiana, Ohio, Kentucky, Tennessee, Missouri, Illinois, Virginia, and New Jersey. There is a log storage yard in New York City. Imported logs have been hauled from the ocean ports of arrival over several differetn railroads to the veneer factories utilized by them. Every Dutch elm disease infection yet discovered in America is related geographically to entry piers where imported elm logs were unloaded or to railroads which hauled them. This information secured during the summer of 1933 furnished for the first time a foundation upon which an intelligent search for the disease could be based.

Meanwhile, scouting for infected trees, delimitation of the infected area around New York City, and destruction of the diseased trees were in progress. Inadequate finances handicapped the work, especially the removal and burning of the infected trees.

The shade tree commissions and the State authorities of New Jersey are to be especially commended for their strenuous efforts to accomplish with inadequate funds this herculean task. It is to be remembered that the part of New Jersey adjacent to New York City is a thickly settled region with many large street, park, and lawn trees. About 7 per cent of them proved to be elms. Of these, less than half of 1 per cent were proved to be diseased. Even in the worst infected spots but 2½ per cent were found infected. Some of the infected trees moreover, were very large, in one case costing as much as $240 to remove and burn.

In New Jersey the disease centers in Essex County, though it also occurs in parts of seven other neighboring counties. Early in the summer campaign it was discovered that the disease had also penetrated into New York State, where it is known in Staten Island, western Long Island, the Bronx, and southern Westchester County. One tree has been found a mile or two across the line in the State of Connecticut. As a whole, the New York infections seem to be more recent than those in New Jersey, and even in the latter State none yet seem to run back more than three or four years.

In September one diseased tree was found in Baltimore, Md., within a quarter of a mile of the pier where logs were unloaded in August. Scouting in Baltimore and at Norfolk and New Orleans failed to reveal any other infected trees.

Preliminary, but as yet inadequate, scouting has also been performed around veneer factories known to have imported elm logs, and a preliminary reconnoissance for elms has been made of the territory along six railroads known to have transported them. The railroad surveys were made too late in the year to have detected any but outstanding outbreaks of the disease, but the elm distribution has been recorded and the way paved for next year's work.

The findings of the 1933 season up to December 20 may be summarized as follows:

New Jersey	762	Graphium-infected trees
New York	83	
Connecticut	1	
Maryland	1	
Ohio	1	
Total	848	

The external symptoms of the Dutch elm disease are wilting, yellow or brown leaves accompanied by brown rings in the young wood. It had been believed that scouting must cease with autumn discoloration of the trees. A survey, however, was undertaken in October and November in a 2,600 acre water reservation within the edge of the infected area and with known neighboring infected trees. Here much of the ground was swampy and was covered with a thicket of native elms. The tall, slender, crowded trees ran as many as 300 to the acre. In an area of 250 acres every elm was climbed and sampled in a number of places with 16-foot pole pruners. As a result, 103 diseased trees were found in the 250 acres surveyed.

Reorganization in the United States Department of Agriculture has divided for the future the responsibility for the work on the Dutch elm

disease. The investigation of the disease and of its causal organism remains the province of the Division of Forest Pathology, Bureau of Plant Industry. The actual scouting and control work is now assigned to a newly organized division, the Division of Plant Disease Eradication and Control in the enlarged Bureau of Entmology. This is headed by Dr. Karl F. Kellerman. With funds supplied by the Civil Works Administration, research on the disease by the Bureau of Plant Industry forces is under way at Wooster, Ohio, in Westchester County, N. Y., and Morris County, N. J. Extensive control forces are being assembled and organized by the Bureau of Entomology in New Jersey, New York, and Connecticut.

Those most familiar with the disease feel that there is a fighting chance to eradicate it, if there is a united and properly financed effort made by all parties concerned, but that half-hearted measure will be of no avail. Temporary funds available till the middle of February will adequately finance the winter research and control, but provision has not yet been made for next season's campaign.

I can but thank you for the hearty cooperation we have received this summer and bespeak of you its continuation in the future.

ADDITIONAL INSPECTION OF NURSERIES ON ACCOUNT OF THE EUROPEAN PINE SHOOT MOTH

By W. E. Britton, *Agricultural Experiment Station, New Haven*

During the past few years the European pine shoot moth, *Rhyacionia buoliana* Schiff., has severely damaged forest plantations of red pine in Connecticut. Most of this damage has occurred in Fairfield and New Haven Counties, but there has also been some damage in the southern portion of Hartford County and the western portion of Middlesex County. In other words most of the severe damage has occurred in the southern central and southwestern portions of the state. There has also been injury to Scotch and Austrian pine in this region but these species are not used so extensively as red pine in forest plantations.

For nearly 20 years red pine has been recommended by our foresters as being the best tree to plant because of its rapid growth and comparative freedom from destructive pests. Millions of red pine trees have been grown by the state and sold at cost to land owners for reforestation planting. Consequently there are now nearly 10,000 acres

of red pine growing in Connecticut, and a record has been kept of the owner and location of each plantation. About 4,000 acres are infested.

The life history and methods of control of the European pine shoot moth have been studied recently by Dr. R. B. Friend and Mr. A. S. West, Jr., and several papers have been published containing the results of these studies.[1]

Damage became so severe that in 1933 the red pine trees in certain areas were cut and burned because they were injured beyond recovery, and adjacent areas not yet injured were endangered. The areas and location of the trees destroyed are as follows:

Bridgeport Hydraulic Co. (2 plantations)	5	acres
New Haven Water Co. (3 plantations)	10	"
Middletown Water Department (1 plantation)	7	"
Total	22	acres

The seriousness of the matter was brought to the attention of the Eastern Plant Board at its April Meeting and the Bureau of Plant Quarantine was asked to call a conference to consider the situation. The conference was held at the Agricultural Experiment Station, New Haven, on September 19, and the subject was fully discussed. A committee of three was appointed by the Chair to draw up recommendations and submit them to the Eastern Plant Board and to the Bureau of Plant Quarantine. This Committee report has just been read by the Chairman, Mr. H. L. McIntyre.

This insect spreads very slowly unless transported. As was brought out in the discussion at the conference, nursery stock is an important agency in disseminating the European pine shoot moth. Pine trees may be shipped anywhere from nurseries, and if infested, may start a new infestation at the point of their destination. Not only are red, Scotch and Austrian pines susceptible, but the mugho pine is commonly infested, though not seriously injured by the shoot moth. Mugho pines are grown in nearly every nursery, are commonly used in landscape planting, and are widely transported.

In Connecticut the statutes require nurserymen to register with the

[1]By R. B. Friend. The European Pine Shoot Moth in Red Pine Plantations. Jour. Forestry, Vol. 29, pp. 551–556, 1931. The European Pine Shoot Moth. Circular 80, Conn. Agr. Expt. Station, 1931.

By R. B. Friend and H. W. Hicock. The Status of the European Pine Shoot Moth in Connecticut. Jour. Econ. Ent., Vol. 26, p. 57, 1933.

By R. B. Friend and A. S. West, Jr. The European Pine Shoot Moth, *Rhyacionia buoliana* Schiff., with Special Reference to its Occurrence in the Eli Whitney Forest. Yale University School of Forestry, Bulletin No. 37, 1933.

State Entomologist on or before July 1 of each year or bear the cost of inspection. As in many other states, the inspection of nurseries is started soon after the first of July and continued until completed, usually early in October. Between July 1 and September 1, the presence of the European pine shoot moth cannot well be detected except by the injury of preceding seasons. Consequently all nurseries that grow susceptible pines that had been inspected during July and August were again carefully examined for this insect. The owners were shown how to detect the infestation, how to remove it by clipping and instructed to eradicate the pest from their nurseries and notify the office. Where trees had been injured beyond the point of profitable recovery, it was recommended that they be cut and burned.

After receiving notice that a nurseryman had finished this clipping, another inspection was made and if the work was found satisfactory the job was approved. If only a few infested tips had been missed, the inspectors clipped them. All clippings were burned. If a poor job had been done by the owner, he was told to go over it again.

As we decided to remove all shoot moth infestation from nurseries we have kept at it until nearly all of them are clean, and the others will soon be finished. This has necessitated four and five visits to some nurseries. This experience has afforded us a good opportunity to observe human nature and has brought us several surprises. One of these is that many nurseries had not been properly cleaned of other pests as claimed by the owners. Some of them have received a sad awakening. They were made to finish the clean-up whether or not a certificate had been granted, and probably in the future some checking system will be necessary before any certificates are issued.

PLANT QUARANTINE LEGISLATION SUPPORTED BY NUMEROUS COURT DECISIONS

By S. B. Fracker, *Washington, D. C.*

Recent court decisions are tending more and more to strengthen the hands of plant quarantine officers. Such decisions show that the higher courts are inclined neither to declare important pest suppression laws unconstitutional, nor to enjoin pest suppression activities on the basis of minor technicalities, nor through mandamus to order the issuance of licenses and permits which the entomologist does not consider justified. I wish to outline briefly those court decisions which indicate the lines along which plant quarantine officers can safely and courageously

proceed and, as a contrast, the actions which are unlikely to survive an attack in court.

It happens that a certain U. S. Supreme Court decision provides a convenient outline under which we can arrange the various decisions in plant quarantine cases. That court has said with respect to the Interstate Commerce Commission (I. C. C. v. U. P. R. Co., 222 U. S. 541 at 547) that "the orders of the Commission are final unless (1) beyond the power which it could constitutionally exercise; or (2) beyond its statutory power; or (3) based upon mistake of law. But questions of fact may be involved in the determination of questions of law, so that an order, regular on its face, may be set aside if it appears that (4) the rate is so low as to be confiscatory and in violation of the constitutional prohibition against taking property without due process of law; or (5) if the Commission acted so arbitrarily and unjustly as to fix rates contrary to evidence, or without evidence to support it; or (6) if the authority involved has been exercised in such an unreasonable manner as to be within the elementary rule that the substance and not the shadow determines the validity of the exercise of the power."

I—Constitutionality of Plant Quarantine Laws.—The constitutional provisions under which insect and disease suppression laws have been attacked are contained in Section 8 of Article I and in the 5th and 14th amendments to the Federal Constitution. The parts of these articles of interest to us are as follows:

Art. I, Section 8, says: "The Congress shall have power * * (3) To regulate commerce with foreign nations, and among the several States, * * ."

The Fifth Amendment provides that "no person shall * * be deprived of life, liberty, or property, without due process of law; nor shall private property be taken for public use without just compensation."

The Fourteenth Amendment states "nor shall any State deprive any person of life, liberty, or property without due process of law."

With regard to the *interstate commerce clause,* the fields of plant quarantine authority of the Federal and State governments, respectively, due to the enactment of the Plant Quarantine Act of August 20, 1912 (37 U. S. Statutes 315), have now been rather precisely determined by the well known Oregon-Washington RR. & Nav. Co. case (270 U. S. 87), decided in the U. S. Supreme Court on March 1, 1926.

This decision was followed by Congressional action in the form of the Joint Resolution of April 13, 1926, amending Sec. 8 of the Plant Quaran-

tine Act, so as to provide that, until the Secretary of Agriculture has issued a quarantine with reference to any particular dangerous plant disease or insect infestation, the State may issue and enforce plant quarantines on account of such pests or diseases which have been found to exist in the other State or portion thereof, against which the quarantine is directed, and thus directly affect the interstate movement of plants and plant products.

The second constitutional point, on which plant quarantine and inspection laws have been called in question, relates to that clause of the Federal Constitution which prohibits the government from depriving persons of property *"without due process of law."* Without exception, the courts have held that this clause does not nullify statutes which authorize the proper State authorities to destroy or treat infected or dangerous property in cases where the State statutes give them that authority. In Virginia, for example, the United States Supreme Court held, in Miller v. Schoene (*276* U. S. *272*), that the cedar rust act of Virginia, providing for the destruction of cedar trees to prevent communication of cedar rust to apple orchards, was not in violation of the due process clause of the constitution, since the State, when forced to choose between destruction of one class of property or another, "does not exceed its constitutional powers by deciding upon the destruction of one class of property in order to save another which, in the judgment of the legislature, is of greater value to the public." (See also Kelleher v. French, *22* Fed. 2d 341.)

In addition to the due process clause, the Fifth Amendment to the Federal Constitution says "nor shall private property be taken for public use *without just compensation.*" With regard to this question, it has consistently been held that such compensation in pest suppression cases is not required, and a fundamental distinction is made between (1) taking innocent and valuable property for public use under the authority known as "eminent domain" and (2) that of condemning diseased or dangerous property under the police power of the State.

In the case of State v. Main (*37* Atlantic 80), involving the destruction without compensation of peach trees infected with yellows in Connecticut, the court said: "Such property is not taken for public use. It is destroyed because, in the judgment of those to whom the law has confided the power of decision, it is of no use and is a source of public danger." Similar Louisiana, Indiana, and Washington statutes and orders have been upheld. (La. St. Board v. Tanzmann, *73* So. Rep. 854; Wallace v. Dohner, 165 N. E. 552; Carstens v. DeSellem, 144 Pac. 934.)

Even where, as in the case of the cedar rust, the disease does not make the cedar trees themselves valueless but merely spreads from them to appletrees, pest suppression laws, without provision for compensation, have been held constitutional. In Upton v. Felton, the U. S. District Court for the District of Nebraska, in 1933, upheld the Nebraska Cedar Rust Law, which makes no provision for compensating the owners of cedar trees that are cut down, and denied an injunction that would have prevented the State officers from destroying such cedar trees in compliance with the State law.

While the courts have thus consistently upheld State statutes enacted under the police power of the State and administrative orders adopted thereunder in good faith to accomplish legitimate purposes, they have shown no sympathy for statutes or orders found to be really adopted to accomplish a purpose not legitimately within the police power (R. R. Co. v. Husen, 95 U. S. 465; Minnesota v. Barber, 136 U. S. 313; Voight v. Wright, 141 U. S. 62; Henderson v. Mayor, 92 U. S. 259). For example, in Brimmer v. Rebman (138 U. S. 78), the Supreme Court held that a State "may not, under the guise of exerting its police power, or of enacting inspection laws, make discriminations, against the products and industries of some of the States in favor of the products and industries of its own or other States."

II—Statutory Authority.—It is, of course, necessary for every administrative officer whether he is enforcing plant quarantines or not, to act within the provisions of the statute from which his authority is derived. Even the unintentional exceeding of such specific authority renders him personally liable for damages. Fortunately, so far as could be learned, cases of this kind seem to have been confined to those involving public health or the diseases of live stock. In 1891, the action of two different State Live Stock Sanitary Boards in condemning horses for glanders was reviewed in State courts (Miller v. Horton, 152 Mass. 540; Pearson v. Zehr, 138 Ill. 48) and judgment issued against the enforcing officers as individuals, on the ground that the statute authorized the killing only of "infected" horses and that since these horses were not infected in the opinion of the judge and jury, the Live Stock Sanitary Board exceeded the authority given in the statute.

In State ex rel Adams v. Burdge et al., School Board (70 N. W. 347), the defendant's children were being kept out of school by the School Board of Beloit, Wis., because their parents refused to comply with an order of the State Board of Health which required universal vaccination as a condition for school attendance. The order had been

issued under a statute authorizing the State Board of Health "to make such rules and regulations and to take such measures as may in its judgment be necessary for the protection of the people from Asiatic cholera, or other dangerous contagious disease." The State Supreme Court held that the statute was invalid as "an absolute delegation of the legislative power" since it was stated so broadly, and that in order to authorize the Board to issue rules and regulations "there must first be some substantive provision of the law to be administered and carried into effect." This decision is of particular interest to State officers who may be relying on very broad and general language as the only basis for the issuance of State plant quarantines. It would appear from this and similar decisions that a quarantine order is likely not to be upheld by the courts unless the State statutes specifically authorize *quarantine* action and prescribe the conditions (such as the determination of the presence of an injurious insect pest in a certain area inside or outside the State) under which such quarantines may be issued. It is suggested that quarantine officers carefully study the statutes under which they are operating, in order that quarantine and other similar orders may not be issued unless and until full and specific authority for them is granted by the legislature "as a substantive provision of law."

III—MISTAKES OF LAW.—The courts have held with respect to the administrative decisions of various boards, particularly public service commissions and the Interstate Commerce Commission, that administrative orders will be reviewed to determine whether there have been errors in *interpreting* the laws on which administrative action was taken. In the case of Lemon v. Rumsey (150 S. E. Rep. 725) certain owners of cedar trees attacked the West Virginia cedar rust law on that basis. They claimed in effect that the five days, including a Sunday within which the owner was ordered to destroy the trees, did not give a reasonable time for the plaintiff to comply with the order; that the destruction of "cedar" trees was covered rather than "red cedar" trees; that the notice did not contain such collateral information as statements on the impracticability of treatment and the reason for the destruction of the trees, and that the notice did not state that a request for such destruction of trees had been signed by ten reputable free holders in the locality in which the cedar trees were located.

In spite of being attacked on all these and several other fronts, both the statute itself and the order issued by the State Entomologist were upheld as complying with the letter and spirit of the State cedar rust law, enacted pursuant to the police power of the State, and the court refused to enjoin the State officers from cutting the trees concerned.

IV—Administrative Orders Final Unless Arbitrary or Unfair.—It has thus been held consistently that regulations and orders issued by administrative bodies will not be reviewed by the courts or disturbed, so long as they are constitutional and have a legal foundation, provided they are not clearly arbitrary or unreasonable. Accordingly, it becomes necessary to find out what the courts mean by arbitrary or unreasonable administrative action.

Dickinson (Administrative Justice and the Supremacy of Law in the United States, 1927), has expressed (p. 320) the usual position of the court as follows: "A determination will be set aside which is without evidence to support it [I. C. C. v. U. P. R. Co., 222 U. S. 541]; or, differently expressed, which could not rationally have been reached by fair-minded men from the evidence." (San Diego Land and Town Co. v. Jasper, 189 U. S. 439).

Administrative decisions and orders have thus been set aside, first, when there was no evidence whatever as to an essential point (U. P. R. Co. v. Milliken, 8 Kans. 647); or second, when all the evidence points in a directly opposite direction (Rowland v. Boyle, 244 U. S. 106; and Dube's case, 226 Mass. 591).

In a plant quarantine case in which this point came up, the judge indicated quite clearly that he probably would not himself have issued the order in question, namely, the Federal Thurberia weevil quarantine, on the basis of the information in the hands of the Department, but he, nevertheless, upheld the Department's action. The case is that of Smith v. Jardine, which was decided favorably to the Department in November, 1930, in the U. S. District Court in Arizona. The judge said:

"I have read and carefully considered the entire evidence, both oral and documentary, introduced at such hearing, and while I might not, upon a consideration thereof, have arrived at the same conclusion, as that arrived at by the Secretary, I can not say that there was no substantial basis of fact to support the quarantine order here involved, neither can I say that the Secretary acted arbitrarily or unfairly.

"The Act of Congress having conferred upon the Secretary of Agriculture the power and duty to find facts and determine conditions upon which the operation of the statute depends, such findings and determination can not be judicially reviewed in the absence of a showing that he acted arbitrarily or unfairly, or that there was no evidence to support such finding and determination."

V—Court Proceedings.—Dickinson (op. cit.) has outlined the five ways in which administrative action can come before the courts for review, as follows:

(1) Civil suits may be instituted against officers as private individuals for illegal acts committed in their official capacity.

(2) In a number of cases, statutes specifically necessitate court action in order to secure compliance with administrative orders.

(3) Courts have the power to issue the orders known as extraordinary writs, namely, mandamus, certiorari, habeas corpus, and injunction.

(4) Even where statutes authorize bodies and departments to enforce administrative orders, such statutes sometimes expressly provide that an appeal from such orders may be taken to court.

(5) Statutes often allow administrative bodies to sue for the expense of executing an order after its nonobservance by the person to whom it was directed.

Plant quarantine and similar statutes have been attacked by most of these five types of procedure and have withstood such attack, but suits of the first of these types have proven the most troublesome. The writer is preparing a separate paper for later publication outlining the experience of plant quarantine officers with these different kinds of court action.

CONCLUSIONS.—1. Courts have repeatedly ruled in favor of the constitutionality of statutory provisions covering plant quarantine, nursery inspection, insect and plant disease suppression, and similar measures in which plant quarantine officers are interested. The ordinary provisions of such State and Federal laws have been held to constitute a proper exercise of the police power of the State and not to contravene either the "due process" clause of the constitution or that clause which forbids the taking of private property for public use without compensation.

2. Regulations and orders issued under State and Federal statutes have been upheld, and attacks on the basis of unsubstantial faults in the record have been unsuccessful. Nevertheless, quarantine officers should be very sure that the action taken is specifically authorized by the statute.

3. State plant boards and departments of agriculture have been delegated the responsibility of protecting agricultural and horticultural interests from severe and increasing loss through preventable attack by insect pests and plant diseases. Court decisions now provide a firm and rather clearly outlined foundation on which such bodies can stand in carrying out that responsibility. They may thus approach the entomological and phytopathological problems arising from day to day and month to month with confidence that any reasonable and legally authorized action will receive court support.

SOME PECULIARITIES OF STATE REGULATIONS CONCERNING THE MOVEMENT OF NURSERY STOCK

By A. G. RUGGLES, *St. Paul, Minn.*

Those of us in Nursery Inspection work in the various states have had to contend from the very beginning with the multiplicity of rules governing the sale and shipment of nursery stock. In the early days of this section of our association this problem was talked about and discussed at every meeting. Out of these discussions came the ideas for the establishment of the four regional Plant Boards and the National Plant Board. One of the objects of the establishment of such Boards was that these regional Boards could study and if possible simplify and unify the regulations of the different states. These Boards in conjunction with our National Plant Board have done much to bring this about. It is well known that these Boards themselves have no power. It is ultimately the state that must have the laws enacted to make for uniformity and justice. Many states have changed regulations materially to meet with the suggestions of their Boards.

In studying carefully some of the rules and regulations of different states now in force, I find there is still room for much improvement. One is forced to believe that (1) in some states the underlying purpose of the out-of-state fee-charging mania is to secure funds for inspection, (2) in others its purpose is probably nothing more than a masked tariff, and (3) in still others, and probably more than we would like to admit, it is a purely retaliatory measure. There are eight regulations which I think should be considered more carefully, either by modifying or dropping them.

These eight are as follows:

1. The following states charge fees to other states wishing to ship nursery stock into them:

Alabama	$10.00	Arkansas	$ 1.00	S. Dakota	$ 1.00	Georgia	5.00
Iowa	5.00	Virginia	10.00	Kentucky	5.00	Missouri	5.00
W. Virginia	20.00	Montana	25.00	New Mexico	5.00	Texas	5.00
Oklahoma	5.00	Oregon	20.00	Washington	5.00	Wyoming	10.00
Idaho	10.00	(if one or more out-of-state agents are employed)					

2. The following states force out-of-state nurseries to furnish bond in order to ship nursery stock into them:

Georgia	$1,000.00	Montana	$1,000.00	Oklahoma	$1,000.00
Utah	500.00	Wyoming	500.00	Michigan	?
Idaho	5,000.00	(if one or more agents are employed)			

3. The following states force out-of-state nurseries to secure *special permit tags* from them to be attached to nursery stock to be shipped into these states:

Alabama	Louisiana	Texas	Arkansas	Mississippi
Virginia	S. Carolina	New Mexico	West Virginia	Florida
N. Carolina	Georgia	Oklahoma	Wyoming	

4. The following states require a special permit be obtained from them before an out-of-state nursery can ship nursery stock into them:

Alabama	Texas	Nebraska	Oklahoma	Arkansas
Wisconsin	New Mexico	Oregon	Connecticut	Kentucky
Virginia	Georgia	Louisiana	W. Virginia	S. Dakota
Indiana	Missouri	N. Carolina	Iowa	Montana
Ohio	Wyoming			

5. The following states force the filing of a special invoice previous to each shipment from out-of-state nurseries:

Arkansas	Mississippi	Texas	Georgia	Montana
Utah	Louisiana	S. Carolina	Washington	

6. The following states require fumigation of nursery stock before it is admitted. (Fumigation is not a dependable procedure for such shipments as is borne out by the recent abolishment of fumigation requirements by the Dominion of Canada and many states).

Florida	Mississippi	S. Carolina	Georgia	N. Carolina	Tennessee

7. *Nevada* requires that all shipments be inspected at the time of shipping.

8. *Missouri* requires that out-of-state nurseries in order to ship nursery stock into that state must sign a statement that the particular stock was grown on its own premises.

After all is said and done, the reasonable, feasible and worth-while requirement is the filing of the certificate of inspection. When a nursery files a certificate of inspection with a state, it indicates its intentions to ship only clean stock and if it violates the meaning of the certificate which it has filed, it can immediately be prohibited from further shipments into such states. It seems that this requirement if properly respected and enforced will carry out all of the obligations necessary for any nursery in any state.

The following states appear to agree with the preceding statement and require only the filing of certificates:

Delaware	Kansas	N. Dakota	Idaho	Maryland
Rhode Island	Illinois	Minnesota	Pennsylvania	

The following states have no special requirements outside the ordinary state certificate of inspection:

Maine New Hampshire New York New Jersey Massachusetts Vermont

Last summer (1933) I sent a statement similar to the above to all the chief quarantine and inspection officials in the various states of the U. S. A. I received replies from 36 states. These replies are exceedingly interesting and if I had time I should like to read them all to you, but will only give a few representative samples:

Arkansas, Paul. H. Millar, Chief Insp. "The fees which we charge out-of-state nurserymen, viz., a $2.50 uniform fee plus 2 cents for each permit, one permit necessary for each shipment, are designed to pay expenses of transit inspections of nursery stock. We endeavor to inspect in transit as many shipments as possible in order to ascertain whether diseased shipments of nursery stock are being sent into Arkansas under our permits.

California, A. C. Fleury, Chief Bur. of Pl. Quar. "I have read with interest your circular No. 2 of July 22, 1933, entitled "State Retaliatory Measures Concerning the Plant Industry." This seems to be one time that California does not come in for criticism of her quarantine policy and procedure, hence presumably we should agree with your conclusions.

".....We feel that we can ably justify on a sound biological basis not only all of the quarantines we maintain but also our present destination inspection procedure....."

Connecticut, W. E. Britton, State Ent. "I have read your Circular No. 2, accompanying your letter of August 25. I am in full sympathy with your statements, except that on registration and filing of certificate in order to obtain a special permit to be able to ship into another state.....

".....We do require them to register on a special form and file a copy of their certificate, which is for the purpose of informing us that their nursery has been inspected in the regular way and that they expect to make shipments into Connecticut....."

New Jersey, H. B. Weiss, Chief Bur. Pl. Ind. "Personally, I am in favor of abolishing all the practices which you have numbered "1" and "8". As you know we have none of these practices in effect in New Jersey. Our policy is to accept the certificate of other states and to examine as large a sample as our force permits, of nursery stock shipped to New Jersey from various states. If we find anything wrong, the stock is either destroyed or returned."

Rhode Island, Chief Bur. Ent. and Pl. Pest Control "It is my feeling in this connection that if fees were charged to nurserymen in states that exact fees from our nurserymen, there might be a reconsideration of the matter in the states affected. A short time ago I had letters from Wisconsin indicating as you state in your circular that they have found a way of doing this without encountering difficulties with the interstate commerce laws which were held up as an obstacle to Rhode Island nurserymen.

"To state the matter briefly we are interested in full freedom of exchange in nursery stock, the same as any other commodity on the basis which you suggest in

your letter and which we now have in force. This plan requires that the nurserymen file copies of official inspection certificates with this office, and unless specific attempts at evading the laws in their own states are evidenced by the kind of stock they were shipping, they are free to ship into Rhode Island without further hindrance."

W. C. O'Kane, Chairman, Nat. Pl. Board. "I have never believed in the desirability of setting up all sorts of state fees and regulations, and I have always felt that these manifold special requirements were harmful rather than helpful."

From the majority of these opinions presented it is seen that many of the regulations referred to are not considered desirable, a few of the less objectionable ones seem to be debatable.

When we know that a regulation is old and obsolete, and if the law allows, it is up to us as inspectors to remedy the situation. If the law does not allow, it is up to us to convince our legislature that the law should be changed. When certain regulations are debatable, they should be brought out in the open for discussion at meetings of this kind. These matters should also be discussed at our regional board meetings and if any decision is reached, it should be passed on to the National Plant Board for transmission to other regional boards. I believe we can help greatly by studying more closely our present rules and regulations regarding shipping of nursery stock, simplifying them when possible, and then making every effort toward uniformity.

For those states who refuse to consider the matter, or whose lawmakers refuse to make desirable changes in their present law, a course similar to that followed by Wisconsin should be adopted. Wisconsin at the last session of the legislature adopted a very sensible regulation to the effect *that the Commissioners of the Department of Agriculture and Markets are authorized to enter into reciprocal agreements with the responsible officers of other states having nurserymen doing business in Wisconsin, permitting these dealers and nuserymen to be issued nonresident licenses without the payment of a registration fee, provided like privileges are accorded to Wisconsin nurserymen.*

GIPSY MOTH WORK WEST OF THE CONNECTICUT RIVER AND IN PENNSYLVANIA AND NEW JERSEY IN 1933

By A. F. BURGESS, *Bureau of Plant Quarantine, Greenfield, Mass.*

Last year the work was reduced greatly in the Barrier Zone in New England. The woodland scouting program was abandoned and the work confined to a limited region in southwestern Massachusetts and northwestern Connecticut, where the most gipsy moth infestations had been found during the last two years. Because of the reduction in funds from $400,000 to $333,000 this year, prospects were not encouraging. Efforts were made to obtain additional funds from emergency appropriations and provision was made for a limited amount of work by personnel at some of the C.C.C. camps. Late in August NRA funds were made available, including $2,020,620 for use in New England and eastern New York, in the Barrier Zone and east of it to the Connecticut River and in Pennsylvania. This is the first time sufficient funds have been provided for work in the Barrier Zone and in the territory bordering it on the east. The assembling of supervisory personnel and the organization and training of men were started immediately. Men were secured through the National Reemployment Service and schools for the training of men were started in Connecticut, Massachusetts, and Vermont in sections east of the Barrier Zone where infestations could be located readily. Fourteen of these schools were established and as rapidly as possible men were assigned to them under capable instructors for two-week periods of intensive training. Work done at the training schools in these three States located more infestations than was anticipated and some badly infested areas were found which, if left untreated, would have caused serious spread. While the work of the men in these schools was primarily for training purposes, the work done by them was of actual value as control. During the course of this training about 37,000 acres of woodland were scouted and over 54,000 egg clusters destroyed. In about six weeks after the funds were first made available, two thousand scouts with necessary supervisors were at work. Much of the work was in remote forested areas and in recognition of this fact five eight-hour days were authorized with Saturday morning work permitted to make up for time lost on account of bad weather.

To escape the obstacles imposed by deep snow and bad roads the plan called for the scouting of the highest elevations and inaccessible sections first. From the northern part of Connecticut to the Canadian border, the height of land coincides with the eastern border of the Barrier Zone

almost without exception. It is planned to scout towns on both sides of this height first so that as much work as possible could be done before deep snow compelled moving to lower altitudes. The complete plan for work under NRA authorization calls for general scouting in the northern half of Vermont of towns in the Barrier Zone and a band of towns east of it; also towns east of the Zone to the Connecticut River in the southern half of Vermont, in Massachusetts, and in Connecticut, except for districts in these three States near where C.C.C. camps are located; and also the extreme southern portion of the Barrier Zone in Connecticut and five towns within the Zone area in Clinton County, New York, where woodland has not been examined heretofore. For the territory in Massachusetts east of the Zone to the River, scouting, whether performed under NRA or C.C.C. camp authorizations, is to be confined to woodland, leaving the open land scouting for State or local authorities. In addition to the territory for general scouting, selected areas in the southern half of the Barrier Zone in Massachusetts and in the Zone in Connecticut are to be subjected to intensive scouting. A majority of the men were assigned to Vermont, which contains a much larger proportion of high land than the other two States, but a few crews were placed in each of these later. To date about 468,000 acres of woodland and some 900 miles of roadsides have been scouted in Vermont, which represents about two-thirds of the highland portion of the area selected for scouting in that State this year. No infestations have been found to date. In Massachusetts and Connecticut, 42,500 acres of woodland and 170 miles of roadsides have been scouted and 625 egg clusters destroyed. In Massachusetts scouting, except for work performed at the training schools, has been confined to elevated sections in the Berkshire Hills, while in Connecticut similar work has been confined to high land sections of the northwestern part of that State which are almost inaccessible during mid-winter. Abnormal snow fall and extremely cold weather in October, November, and December has materially retarded the progress of the field work so that the program is behind schedule at the present time.

In the southern part of the territory, in those parts of Massachusetts and Connecticut nearest the Connecticut River, the records obtained from the training schools would indicate that there are a considerable number of infestations. Work has not progressed far enough to give an adequate idea of what will develop but it is evident that a large amount of cleanup and spraying will be required before the end of the fiscal year. Some very heavy infestations have been found by local authorities in

towns adjoining the Connecticut River on the east, and an estimated 100,000 egg cluster infestation discovered on a small island in the River in the Town of Hadley, Mass. Treatment is being applied there which is a dangerous location for spread through driftwood during high water in the spring. On the north side of Mt. Tom which lies partly in the city of Holyoke, Mass., and partly in the Town of Northampton, a severe infestation was found which has great possibilities of spread through wind dispersion of small larvae. The mountain is steep sided with many huge ledges which make precarious footing for the tree growth. Trees growing in such locations could not withstand the injuries caused by many defoliations and their destruction would detract from the natural scenic beauty which attracts many tourists each year.

Work in the C.C.C. camps which was authorized last spring is being carried on exclusively in territory west of the Connecticut River under the direction of Mr. S. S. Crossman. Experienced foremen have been detailed to four camps in Connecticut, ten in Massachusetts, and one in Vermont. The original plans called for the detailing of one hundred men from each of the Connecticut and Vermont camps and twenty from each of those in Massachusetts. For different reasons the number of available men has been reduced greatly from the planned numbers. This was advantageous during mid-summer when conditions for training men were not so satisfactory as later, after the egg clusters had been deposited. The plan has been to carry on as much scouting as possible in towns around the camps, to cut the amount of travel to a minimum, and increase the amount of scouting and cleanup work that can be done during the present fiscal year. Much work has been done already in towns near the camps. By the middle of December the average number of men engaged daily in gipsy moth work was 457. From the beginning of this work 64,500 acres of woodland and 506 miles of roadsides have been scouted and over 35,000 egg clusters destroyed.

Last year the gipsy moth situation was very serious. We had found a large colony in Pennsylvania, but funds were inadequate and no real cleanup work could be undertaken there until the first of last February. Through the medium of Pennsylvania Relief Funds it was possible to place 200 unemployed men at work on a stagger system with each man getting employment for about four weeks. All work was performed under the direction of trained Federal supervisors. Because of the limitations of time and funds, it was not possible to determine the furthermost limits of the infested area but in the time available for such work, scouting discovered over 230 square miles to be infested. The

principal control work was performed in the generally infested central portions of the known infested area. Over 1,800,000 egg clusters were destroyed; over 1200 acres were cleared of brush and worthless trees, the brush and slash burned and egg clusters treated. In the spring over 5000 properties were sprayed after permits were obtained from the owners or renters.

Because of shortage of funds most of the men were laid off in July. In August under National Recovery Administration approval, work was resumed on an enlarged scale. Through NRA funds, $500,000 of which was allotted for this project, and a small appropriation from the Pennsylvania Legislature, about 500 men were put to work. The task of building up the force was started about the first of September and by the first of October, after suitable training, some 350 men were engaged in scouting and cleanup work and over 100 in cutting out brush and worthless trees. Scouting has been done just outside of the area found generally infested last year, particularly in sections almost inaccessible during the winter. To the middle of December nearly 22,000 acres of woodland, 33 miles of river banks and 115 miles of roadsides in open country have been scouted; 146 infestations found and nearly 117,000 egg clusters destroyed. Just outside of the area in which similar work was performed last year, 664 acres have been freed of brush and worthless trees, the bush and slash burned which destroyed tens of thousands of egg clusters.

Scouting to determine the extent of the area infested is being performed outside of the area found infested last year. Colonies have been located northeast, east, and south of last year's limits at distances of several miles.

To prevent artificial spread from the infested area a State quarantine enforced by Federal authorities was established March 15, 1933. Many thousands of feet of lumber have been inspected together with thousands of mine props, some cordwood, cable reels, nursery stock and numerous cars of junk metals. A small number of egg clusters have been found this Fall in the area on materials that were about to be moved. These were treated and the shipments certified so that distribution by this means could be prevented.

In New Jersey scouting work has been performed entirely by a small force of State employees. They have confined their work to two towns, covering as completely as possible an area in which a single male moth was captured last summer. Three hundred and forty-eight acres of woodland have been scouted carefully but no signs of infestation discovered.

It is expected that far more will be accomplished on the gipsy moth propect this year than ever before and that substantial progress can be shown before the end of the spraying season next summer. Through necessity, since the establishment of the Barrier Zone, all Federal control work has been confined to that area. There was little doubt of the existence of infestations east of the Zone which were sources of danger for the Zone itself, but no control work could be undertaken. Under the new authorization these infestations can be scouted out, in fact some have been located already, and either eradicated or so reduced in size that their dangerous character will be eliminated. For nearly twenty years the United States, outside of New England, has been effectively protected from gipsy moth losses by quarantine enforcement which protected against long distance spread. For ten years the rest of the country has been protected against the gradual encrouchment of this serious pest by the Barrier Zone thrown across the line of its westward march. This line must be held in the future as effectively as it has been in the past.

The gipsy moth work is an outstanding example of successful prevention of long distance spread through quarantine enforcement, and of local spread by maintaining the Barrier Zone. These results, coupled with complete extermination of the insect over large areas, furnish a practical demonstration of effective handling of a major introduced insect pest.

ACTING CHAIRMAN HADLEY: Mr. McIntyre will present the report of the Committee on European Pine Shoot Moth Control. It was published in the February 1933 issue, pages 208–209.

PROCEEDINGS NATIONAL PLANT BOARD MEETING

October 24, 1933

A special meeting of the National Plant Board called by Chairman W. C. O'Kane was held in Washington, D. C., October 24. Attending were Messrs. W. C. O'Kane, J. F. Adams, G. A. Dean, K. C. Sullivan, M. S. Yeomans, R. W. Leiby, and Director of Agriculture A. A. Brock of California, the latter representing the Western Plant Quarantine Board.

An informal meeting held in the afternoon to which state plant quarantine officials and nurserymen were invited was attended by thirty individuals interested in Federal quarantine 37 which was the subject of a public hearing by the Bureau of Plant Quarantine on the next day. The free discussion at the meeting strongly indicated the wish that quarantine 37 be strengthened.

At the night session of the Board, Dr. Wilmon Newell and Dr. J. H. Montgomery of Florida urged the approval of a plan for Federal certification of nursery products under uniform Federal standards. The plan embodied inspection by state officials and inspectors, but under Federal supervision. The creation of a Board

to review state and federal domestic quarantines was also proposed. By motion, Chairman O'Kane was instructed to confer upon these matters with the proper officials.

By motion the Chairman was instructed to voice the Board's wish at the public hearing of October 25 that the provisions of Federal quarantine 37 be tightened rather than modified, and that the Board considers the introduction of plants for general sale as offering too much risk to be continued. It was strongly urged that imported plants be referred to detention gardens for observation by the Bureau of Plant Quarantine for a sufficient length of time so they could be declared free of pests of all kinds.

A committee of the Board which has under preparation a set of Principles of Pest Compensation reported progress. These principles are to be a companion set to those on Plant Quarantine issued by the Board and approved by the regional boards two years ago.

Approval of the state quarantine restrictions governing the movement of Irish potatoes from potato wart infested districts was voiced by the Board, following the report of a conference at Hazleton, Pa., by J. F. Adams. In this connection the Board endorsed the immediate application of methods leading to eradication of the disease by chemical treatment of the soil. Stringent regulations preventing the importation of potatoes were urged.

PROCEEDINGS OF THE SOUTHERN PLANT BOARD

Annual Meeting, Memphis, Tenn., January 31, 1934

The annual meeting of the Southern Plant Board was held at Memphis, Tenn., on January 31, 1934, coincident with the meeting of the Cotton States Branch of the American Association of Economic Entomologists held on February 1. All states except Oklahoma, Texas and South Carolina were represented at what proved to be a most interesting meeting.

No formal program of papers was followed, but the discussion on state quarantines regarding cut flowers and bedding plants was free and interesting.

W. C. O'Kane, Chairman of the National Plant Board and an invited guest reported upon a conference he had had with Asst. Secretary of Agriculture Tugwell, regarding Federal certification of nursery plants and shrubs. A resolution was adopted by the Southern Plant Board urging the National Plant Board to take further steps to consummate a plan of state inspection under Federal supervision and certification, and to present a plan to the regional Boards for consideration at an early date.

In addition to plant quarantine officials of the Southern Board there were in attendance at the meeting a number of inspectors of the Mississippi Plant Board, Professor W. C. O'Kane of Durham, N. H., and Messrs. L. A. Strong, A. C. Hoyt and R. W. Harned of the Federal Bureau of Entomology, whose remarks contributed to the success of the meeting.

REPORT OF THE WESTERN PLANT QUARANTINE BOARD

The fifteenth annual conference of the Western Plant Quarantine Board was held at Salt Lake City, Utah, June 12–14, 1933. Mr. David F. Smith, Commissioner of

Agriculture of the State of Utah, and his staff did everything possible to make this meeting a success and our stay in their city a delightful one.

Some very interesting and constructive papers were read and addresses given on subjects of interest to the Board members. These comprised "The Fruit Fly Situation in Mexico," by Sr. E. Coppel Rivas of the Department of Agriculture of the Republic of Mexico; "Bacterial Wilt of Alfalfa" by Dr. B. L. Richards of the Utah Agricultural College; "The Control of Tomato Bacterial Canker" by Professor H. L. Blood of the Utah Agricultural College; "Cooperation of the Postal Service in Connection with Plant Inspection" by W. W. Wood, Superintendent, Division of Classification, Post Office Department, Washington, D. C.; "How the Farmers Handle Legislation in California" by Ralph Taylor, Secretary, Agricultural Council of California, and several others of equal importance.

Interesting reports were made by the quarantine officials of the various member states, British Columbia and Mexico, on quarantine developments and pest control conditions in the areas under their jurisdiction. Professor George M. List of Colorado reported on the proceedings of the annual National Plant Board meeting which had been held in St. Louis earlier in the year. As in the past, much benefit was derived from informal discussions on subjects not on the program but brought up during the session for consideration by the various members or as a result of special or standing committee reports. These comprised:

(1) *Pest Treatments.* The Committee on this subject reported on

(a) Hot vapor treatment to test the ability of California fruits to withstand such treatment which is known to be entirely effective to fruit fly, this work being conducted as a preparedness program to develop data on possible means of handling California fruit in the event the state should be invaded by Mediterranean fruit fly.

(b) The use of liquid insecticides instead of fumigation against date offshoots infested with the Marlatt scale.

(c) The oil dip treatment of Mexican limes infested with various scale insect species.

(d) The oil dip treatment of holly to destroy the scale *Aspidiotus britannicus.*

(e) Oil spray treatment as against obscure scale, *Chrysomphalus obscurus.*

(f) Atmospheric fumigation with hydrocyanic acid gas as against the granary weevil in warehouses.

(2) *Alfalfa Weevil Quarantine Modifications:* The Committee appointed at the 1932 meeting of the Board to secure on the part of the western states a modification and uniformity of quarantine action as against the alfalfa weevil reported that their objective had mainly been accomplished.

(3) *Transportation Quarantine Schedules:* Committee concerned with devising a method and putting it into effect whereby transportation agents might have available in summarized form the plant quarantines of the various states reported as follows:

Apparently now railroad agents are furnished with copies of the complete quarantines of the states and the Federal Government, these frequently being of considerable length and difficult of interpretation by a transportation agent, and particularly difficult to make use of under the present system where they are not summarized. It was pointed out that there has just been issued in revised form Miscellaneous Publication No. 80 of the U. S. Department of Agriculture entitled "Summary of State and Territorial Plant Quarantines Affecting Interstate Ship-

ments" which seemingly, if placed in the hands of each common carrier transportation agent, will prove valuable and furnish them the summarized quarantine data they should have. Correspondence with Mr. Strong of the Federal Bureau of Plant Quarantine indicates his intention of having the information contained in this Publication kept up to date. He further is willing that the data and information given in this Publication be reprinted or otherwise issued by the transportation companies or by any agency designated by them for that purpose and distributed to common carrier agents. Although this Publication does not brief the general laws or regulations of the several states covering the requirements for shipping nursery stock into such states, it seemingly accomplishes the purpose for which this particular committee was appointed.

(4) *Nursery Stock Certification:* This Committee stressed the point that nursery inspection certificates to be of any real value should refer specifically to the particular stock involved in each shipment and not to the fact that the nursery in which the stock was grown was inspected several weeks or months previously. It was also pointed out that a proper inspection certificate issued at origin based upon actual inspection of the plants in the shipment and affirming their pest freedom is of vital importance to nurserymen shipping stock as well as to the consignee. It will go a long way towards insuring against nursery stock being rejected at destination for some insect pest or disease and hence will materially protect nurserymen against a loss that might otherwise be incurred.

(5) *Weed Control:* The subject of weed control evolved more discussion at this conference than any other subject. The Committee appointed to review this subject reported that the rapid spreading of noxious weeds in the western states constitutes a real challenge to agriculture. Two outstanding problems present themselves; first, the problem of eradication. More scientific information is needed on how to eliminate noxious weeds when they are once established. Second, the problem of prevention. It appears that we are planting noxious weed seed faster than we are eradicating the weeds and that the importance and seriousness of this situation is not fully appreciated at the present time. Undoubtedly many bad infestations of such weeds as whitetop or hoary cress can be traced to alfalfa or other field crop seed. Russian knapweed undoubtedly came in with alfalfa seed from Turkestan and many like instances might be repeated. This Committee recommended

(a) That the Western Plant Quarantine Board again send a resolution to the Secretary of Agriculture calling his attention to the seriousness of the weed problem and asking assistance in coordinated research work to determine methods of eradication and that we further request that the United States Department of Agriculture make a survey and investigation of the weed situation of the Western States in order that they might more clearly understand the problems which confront these states.

(b) That the Western Plant Quarantine Board respectfully request the Secretary of Agriculture use his influence to have properly available funds or such funds as are at his disposal allotted to the Departments of Agriculture of the Western States, conducting weed control programs to be used in assisting in noxious weed eradication and control.

(c) That the Western Plant Quarantine Board go on record favoring legislation and regulations placing noxious weeds in the same category as pests and subject to being handled in the same manner as insects or plant disease pests.

(d) That the Western Plant Quarantine Board favors a modification of the general uniform seed law so as to place definite restrictions on the sale of contaminated seed.

(e) That a list of weeds considered noxious in each state be filed with each of the representatives of the Western Plant Quarantine Board and that each State use its services in preventing so far as possible the shipment of such seed to any other state.

(f) That we petition the Secretary of Agriculture to request the Post Office Department to require that all seed sent through the mail be labeled in compliance with the laws and regulations of the State into which it is to be sent.

(g) That the Western Plant Quarantine Board favors a comprehensive educational campaign in the several states with the object of bringing to the farmers and agricultural organizations of each state the importance of purchasing and planting only clean seed free from noxious weed seed and solicit their cooperation in the enforcing of adequate pure seed laws.

(h) That the Secretary of the Western Plant Quarantine Board be instructed to write immediately to the chief of the Biological Survey insisting that a sample of all grain used in the preparation of rodent control bait be first officially analyzed and that all such grain found to be contaminated with noxious weed seed be rejected and only grain found to be free from noxious weed seed be used in the future.

(6) *Phony peach disease:* The recommendations of the National Plant Board with reference to uniform quarantine action to cover this disease was referred to each of the member states for the benefit of those that might wish to place a quarantine against the phony peach disease.

(7) *Oriental fruit moth:* The seriousness of this insect was stressed and the menace presented to the western states from its steady spread westward was the subject of much discussion. The fact that it had recently been reported from both Missouri and Kansas was brought out.

(8) *Strawberry Iris Worm* (CNEPHASIA LONGANA). All present available information in regard to this pest which consisted of a report of the studies made by the Oregon Experiment Station at Corvallis, Oregon, and a letter from Mr. Strong to Professor O'Kane were submitted and as there was still a lack of definite information with regard to the life habits and methods of spread of this pest, it was decided that the Committee would keep in touch with the situation, particularly with the Department of Entomology of the Oregon Experiment Station where investigations of the life history of this pest are now under way and would report back at the next meeting of the Board with recommendation for further action.

(9) *Control of Truck Movement:* The problem of proper quarantine control of trucks transporting interstate plants and plant products, particularly fruits and vegetables, was discussed. It was recognized that this problem could be met only through the establishment of road inspection stations at state borders or other strategic points. Some states require certification from origin to accompany certain types of plant products entering their state. As identity of the commodity certified would be difficult to maintain when moved by truck, it was recommended that the following sealing arrangement be adopted that would prevent substitutions enroute:

(a) In the case of closed or boxed trucks, an official seal to be placed on the door in a manner to prevent the removal or substitution of the commodity carried without breaking the seal.

(b) In the case of open type trucks, the load to be completely covered with a canvas to be officially sealed at all four corners in a manner to prevent any removal or substitution of the commodities carried without breaking the seal.

Among the important resolutions adopted were the following:

(1) Requesting the Secretary of Agriculture to seriously review the present situation wherein no recognition of state plant quarantine regulations is given by the Post Office Department in the case of parcel post mail, thus greatly hampering proper quarantine enforcement by state officials. In an endeavor to devise some method satisfactory to both the Post Office Department and the Department of Agriculture wherein this present unfortunate situation can be overcome, this resolution pointed out that at the Salt Lake conference a proposal was made by Mr. Wood to the Post Office Department of a plan that would be acceptable to the Post Office Department.

(2) In recognition of the additional and possibly unwarranted hardships that might result to commerce when federal domestic quarantines are revoked because of lack of appropriation or for other like reasons and are superseded by quarantine action by the states, the member states of the Western Plant Quarantine Board agreed to the principle that under those conditions, recognition and acceptance would be given in state quarantines to federal origin inspection and certification as a basis for admitting commodities that might otherwise be embargoed.

(3) Requesting the Chief, Bureau of Biological Survey, to provide for more complete enforcement of those provisions of the Lacey Act that restrict or prohibit the entry of injurious mammals and birds from foreign countries by taking advantage of the cooperative willingness of the Bureau of Plant Quarantine to have the plant quarantine inspection personnel of that Bureau now stationed at ports of entry designated as enforcement officers.

(4) A resolution which had been passed at several previous meetings of the board was again passed at this meeting, requesting the Secretary of Agriculture to make provision for systematic and basic investigations for the control or eradication of important weed species and to have a survey of the weed situation in the western states made in order that there might be a clear understanding of the weed problem which now concerns those states. This resolution was based upon the fact that the weed control problem is yearly becoming more serious to the west and that the Federal Government is the only agency that can properly undertake and correlate investigations to avoid duplication of effort and expense by the several affected states.

The officers elected for the ensuing year are W. H. Wicks of Idaho, Chairman; D. C. George of Arizona, Vice-Chairman; A. C. Fleury of California, Secretary-Treasurer; and George M. List of Colorado to succeed George G. Schweis of Nevada, and to act with A. C. Fleury of California as representative to the National Plant Board.

The next meeting of the Western Plant Quarantine Board was set for some time in June, 1934 to be held at Victoria, British Columbia.

Respectfully submitted

A. C. Fleury, *Secretary,*
Western Plant Quarantine Board

REPORT OF THE COMMITTEE ON RESOLUTIONS

(1) Resolved that the Section of Plant Quarantine and Inspection of the American Association of Economic Entomologists subscribes to and urges the continued adherence to the principles of plant quarantine adopted by the National and Regional Plant Boards.

(2) Resolved that the Section of Plant Quarantine and Inspection of the American Association of Economic Entomologists expresses its appreciation of the services of the Committee on Arrangement in providing facilities for the meeting of this Section.

L. A. STEARNS
J. S. HOUSER
Committee

On motion the report was adopted.

The Nominating Committee made the following recommendations:
Chairman: A. S. Hoyt, Washington, D. C.
Secretary: S. B. Fracker, Washington, D. C.

L. S. MCLAINE
RAY HUTSON
C. A. WEIGEL

On motion the report was adopted and the officers named declared elected for the ensuing year.

Mr. S. B. FRACKER: In the December number of the Journal there appears a report by a special committee on the editorial policy of the Journal. It would seem that the committee in submitting this report was not fully advised as to certain of the needs of the Plant Quarantine and Inspection Section, especially with respect to the publication of papers by non-members and of papers relating to certain phases of phytopathology as distinguished from entomology. It is therefore suggested that the chairman appoint a committee of this Section to keep in touch with the Journal committee and to advise with them as to the needs of the plant quarantine officers. I move that such a committee be appointed.

The motion was seconded and adopted.

The chairman appointed S. B. Fracker and L. S. McLaine on that committee.

The meeting adjourned at 5 o'clock.

Apicultural Section

Dec. 27th, 1:30 P. M.,—Bradford Hotel, Boston, Mass.

Committees appointed by Chairman W. E. Britton:
Resolution Committee: C. R. Kellogg and Philip Garman.
Nominating Committee: E. F. Phillips and R. L. Webster.

REPORT OF THE NOMINATING COMMITTEE

The committee recommended the following officers for the coming year:
W. H. Brittain, Chairman.
W. A. Price, Secretary.

REPORT OF COMMITTEE ON RESOLUTIONS

WHEREAS the beekeeping industry is dependent on fundamental research, that this section go on record as supporting this form of scientific endeavor in all possible form.

WHEREAS there is much need for stocks producing more honey or which are better adapted for pollination, *be it resolved* that all efforts by the U. S. D. A. be encouraged by the various Experiment Stations and Agricultural Colleges.

WHEREAS it is often impossible to obtain an adequate idea of annual trends in beekeeping research, *resolved* that this section go on record as favoring a short annual symposium (within the section) summarizing research of the current year and suggesting promising lines of endeavor for the ensuing year or years.

Submitted by
PHILIP GARMAN, *Chairman.*

MISCELLANEOUS PROBLEMS IN BEEKEEPING

By W. E. BRITTON, *Agricultural Experiment Station, New Haven*

When foul brood inspection was first started in Connecticut in 1910, more than 75 per cent of the apiaries and 51 per cent of the colonies were infested with European foul brood. This percentage has shown a gradual reduction each year until 1932, when not a single case of European foul brood was discovered. This disease was not found in 1933. On the other hand, no American foul brood was found for the first four years. Since then it has been present each year, and it has increased during the last ten years although not in a gradual progression. The highest percentage was in 1930, when five per cent of the apiaries were diseased. American foul brood, then, is one important problem of the beekeeper in the eastern states. How can it be stamped out? Evidently the best remedy is to burn all frames of diseased brood and to disinfect the hive bodies, covers and bottom boards, but under present

conditions it is almost impossible to inspect all apiaries, even if we could find them. Then there are countless colonies of wild bees, in which the American foul brood may persist. There is a possibility that through genetic studies the resistance of bees to foul brood may be increased.

Another problem in the northeastern states is the shortage of pasturage for bees. Here there is a great variety of honey plants, none of which grow in great abundance, or last long enough to enable the bees to lay in extensive stores of honey. Sumac is one of our best plants, but in some years the blooming season is too short. Usually we obtain a good honey flow from the various species of asters late in the season. Should not we attempt to cultivate large areas of honey plants for our bees? I understand that there is now a late-blooming sweet clover, that with the earlier blooming strains will greatly prolong the season of honey flow from sweet clover. This addition may be of considerable advantage to beekeepers.

The poisoning of bees by the sprays and dusts applied to control leaf-eating insects is a problem of considerable magnitude. We constantly advise orchardists not to spray while the trees are in bloom, and most of them heed this advice, but when a grower has extensive orchards and there is some stormy weather, it is often a difficult matter to cover all of the trees within the time when the application should be made. So they start before all of the petals have fallen, and some of the bees are poisoned. So far as I can learn there is even more danger from arsenical dusts than from sprays.

The use of package bees for ensuring orchard pollination is still practiced, but it is advisable to have large and strong colonies wherever possible. The owner of one of the largest Connecticut orchards keeps 87 colonies of bees just for the purpose of better pollination. Of course these colonies are so placed that all of the blossoms will be visited by bees.

There are possibilities of improving bees by breeding and genetic studies (1) for commercial honey production; (2) for orchard pollination by obtaining strains that will work in cool weather, or perhaps without requiring such a large brood nest as appears desirable for the Italian bee. Perhaps there should be increased activity in importing the Chinese bee and the various Caucausian strains of *Apis mellifica*, as reported by Dr. Phillips. A scientific study of the characteristics of queens produced by different methods, may bring us valuable information.

There should be further refinement and development of apparatus for

artificial insemination, as the instruments in present use are difficult to make or obtain.

We believe that careful biochemic studies and dietary experiments should be carried on with animals, to determine the influence of honey on growth and development, in comparison with other sugars.

I regret that I am unable to contribute anything toward the solution of these problems, but mention them here to stimulate discussion, and in the hope that someone may become interested and take hold of one or more of them in earnest. I wish to register an emphatic plea for more research, carefully and scientifically conducted, on apicultural subjects.

PROBLEMS IN APICULTURE

By Herbert Osborn

Your secretary has invited me to make some remarks concerning my early experiences in bee-keeping and I recall with pleasure some of my early contacts with bee-keepers and various workers in the field of apiculture.

Perhaps my earliest interest in the subject was awakened by contact with a local bee-keeper, Mr. Messenger, from whom I secured my first colony of bees, while still quite young, probably about the year 1870. There was also a young man who maintained quite an apiary near my home and from whom I received considerable assistance in my first experiences with bees. I remember also meeting Mr. Thomas A. Newman of Cedar Rapids, Iowa. He was at that time the manager of the American Bee Journal with W. F. Clark and Mrs. E. S. Tupper as editors. The Journal at that time was being published from Cedar Rapids and Chicago, but later, around 1878, from Chicago with Mr. Newman as editor and his son as managing editor or manager. I need not mention here the important place that this Journal has occupied in the development of American apiculture.

It was also my privilege to know Professor A. J. Cook of Michigan who was a very enthusiastic apiarist and author of "A Manual of the Apiary" which had extensive circulation some forty years ago. Mr. Eugene Secor who was much interested in apiculture, was for a time a trustee of Iowa State College and much interested in the development of the College Apiary which was maintained at that time mainly as a means of instruction for students interested in the subject. The Reverend Oscar Clute of Iowa City was an enthusiastic apiarist who gave me

considerable assistance in developing a college apiary. I think the first book on apiculture which I used was the classic "Hive and Honey Bee" by Langstroth and it might be of interest to you to recall that Langstroth resided at Oxford, Ohio, and it was there, I think, that he did much of his important research on bees. He was a clergyman, evidently a man of scholastic attainment and I have no doubt was associated with the members of the Miami University Faculty although I do not know that he had any official connection with the institution.

To Langstroth we certainly are indebted for much of the activity in the importation of the Italian race of bees which was a notable advance for apiculture a generation or more ago. Of his "Honey Bee" King says "It lacks the practical character of Quinby's work but is far superior in scientific accuracy and beauty of expression to any American work which has yet appeared or probably will appear, because henceforth the demand is for something more practical."

Of course the works of King, "Beekeepers' Text Book," Cook—"Manual of Apiary", Quinby—"Mysteries of Bee Keeping", Root—"A. B. C. of Bee Culture" and others, and later of Cheshire and Phillips, have carried the subject much farther than in the early period. It is perhaps also of interest to note that during the sixty years in which I have had opportunity to know something of the progress in bee culture, that this period has included most of the developments in the use of the movable frame hive, the honey extractor, the use of the artificial comb, of comb foundation, sectional comb and the use of supers; the introduction of various races of European bees; and the development of queen-rearing and development for distribution of package bees. All of these developments can, I think, be traced directly to researches and a survey of the research work done upon bees that carry us back in history. Some of the most important developments include such names as Huber, Dzierzon, Langstroth, Cheshire and many recent workers whose names are linked with the development of modern apiculture.

I may perhaps recall that apiculture and the entire beekeeping industry is based upon the nectar-producing factor in flowering plants and that the honey bee is to be ranked as the most successful machine for the securing of this nectar. Without honey plants we would have no nectar, without nectar we would have no bees, and no bees—no honey. No commercial method has ever been devised for producing honey except by the aid of the bee and it seems doubtful if any plan approaching commercial success is likely to develop. If it should, or the chemists provide a synthetic honey of practical value, we would perhaps lose the great sport of keeping bees.

But, in spite of the basic nature of the honey plant in the honey industry, we have, as far as I know, simply accepted the nectar-producing ability of plants without attempting to modify them as to quantity or quality of the nectar produced. Human efforts have brought about tremendous changes in plant products by artificial selection and breeding. We have vastly improved production of sugar in sugar cane and sugar in beets; in quantity and also the quality of flavor and quantity of crop in a host of different fruits, and of beauty of color and form in innumerable kinds of flowers and in yield of quantity or character of our most important staple crops such as corn, wheat, rice and others. But so far as I know no specific attempt has been made to change either quantity or quality of nectar for the purpose of advancing the honey industry. We have here, perhaps an opportunity for some investigator to contribute largely to the industry by selecting the most available honey plants and breeding with particular reference to nectar production. This might in a few generations, possibly in a life time, result in considerable advancement in this direction. Possibly the direct effort to breed red clover with short corolla, making available the rich stores of nectar in clover fields, would result better than an effort to breed long-tongued bees, but both plans are of course open to future effort. It is perhaps self-evident that greater nectar production is most likely to come from increase of crops of basic importance in agriculture as honey production will almost certainly continue to be a secondary factor in crop cultivation.

We have lately seen considerable attention paid to the relation of bees to the pollination of various crops, most particularly for orchard crops, but there is no doubt a large field for research in the relation of bees to various field crops, meadows and pastures which are likely to be studied more fully in the future.

As to other possible lines of research many of you are better qualified to suggest than I, but it might be in place to mention that there seems to me much opportunity still for study of the biology of the honey bee. There are undoubtedly many features of activity in the colony which are not yet fully understood and detailed experiments with regard to these activities will undoubtedly be followed in future investigations. Recent studies on the optimum hive temperature in different parts of the hive, and relations of ventilation and humidity to bee activities are quite evidently steps along a path that may lead to decided practical value. The discovery of a successful method of artificial fertilization has opened the way for much exact work in breeding and development of genetic studies,

and observations on the field activity of bees are still open. It is only necessary to mention the large subject of bee diseases and bee parasites to indicate the unsolved problems which are open for students of the future. There is also, it seems to me, still opportunity for studies upon the nutritional value of honey, its relation to diet, and there is also a distinct necessity for studies in the field of marketing for the products of the apiary.

TREATING COLONIES AFFECTED WITH AMERICAN FOULBROOD WITH A BACTERIOLOGICAL VERIFICATON

By W. E. DUNHAM and P. E. KING,[1] *The Ohio State University*

The main factor instigating this line of investigation was the limited amount of experimentation conducted under controlled conditions on the much discussed subject of treating colonies affected with American foulbrood.

Before organizing the experiment, we first conducted a brief survey to attempt to learn what methods were employed by beekeepers in treating diseased colonies, data pertaining to their exact procedure, and their degree of success. It was astonishing how few beekeepers (both commercial and amateur) were able to give detailed information relating to the conditions under which they were working, and how few thoroughly understood the disease. See Table 1. These data show two methods employed by the beekeepers interviewed. In the first method the bees were shaken into an empty hive body and at the end of 48 hours the comb built by the bees was removed and the hive body filled with full sheets of foundation. The second method envolved shaking the bees from the diseased colony directly on full sheets of foundation. These assembled data were particularly valuable since they gave the history of the colonies for a two-year period.

PROCEDURE.—In presenting the methods employed in carrying out this experiment, the general set up will be divided in two distinct parts: that relating to field procedure, and that relating to laboratory procedure.

FIELD PROCEDURE.—In carrying out the experiment in the field it was necessary, as far as possible, to work under controlled conditions which meant that an area within a radius of three miles around the point chosen

[1]Full acknowledgment is due Dr. Starin, Department of Bacteriology, under whom the bacteriological phases of the experiment were conducted.

for the experimental apiary should be free from American foulbrood. This involved thoroughly checking the afore-mentioned area for diseased colonies of bees and the disposition of any bees or bee equipment which might be infected with American foulbrood.

TABLE 1. RESULTS OBTAINED BY BEEKEEPERS WHEN TREATING COLONIES AFFECTED WITH AMERICAN FOULBROOD

Identification of Beekeeper indicated by number	Number colonies treated	Method used	1931 number reoccurrences of A. F. B.	1932 number reoccurrences of A. F. B.
1	1	Empty Hive plus foundation	0	0
2	66	"	0	0
3	4	"	0	0
4	4	"	0	0
5	5	"	1	2
6	1	Foundation	0	0
7	5	"	0	0
8	22	"	4	0
9	9	"	6	0
10	49	"	9	7
11	32	"	7	7
12	44	"	17	?
13	16	"	3	?
14	7	"	5	7
15	6	"	2	2
16	8	"	0	0
17	17	"	0	0
18	4	"	2	0

The treating of the diseased colonies was arranged in three series which were: Series I, Natural Shaking; Series II, Starving; Series III, Feeding.

Series I—Natural Shaking. In this series there were twelve three-frame nuclei hives used representing four types of environmental conditions within the brood nest. Of these, three were empty hive nuclei, three were nuclei hives containing full sheets of comb foundation, three were nuclei hives containing two frames of foundation plus one frame of drawn comb, and the remaining three were nuclei hives containing drawn combs. When shaking the bees from the diseased colonies to the different types of nuclei hives used, precautions were taken to prevent the bees from filling up on honey in the hive. These precautions involved working with very little or no smoke, avoiding jarring the hive, avoiding smearing any diseased honey on the bees, equipment or upon the ground, working as speedily as possible so as to reduce to a minimum the time interval during which the diseased material was exposed, and also giving immediate attention to the proper disposition of the diseased material.

Series II—Starving. In this series the same number and types of nuclei hives and the same method of transferring the bees were employed as in Series I. However, in this series the bees were starved from thirty-six to forty-five hours before placing the hives on their permanent stands in the experimental apiary.

Series III—Feeding. In this series the same number and types of nuclei hives and the same method of transferring the bees were employed as in Series I and II. In this series, however, the nuclei hives were taken to a room so arranged as to exclude any other bees, and there fed a honey solution heavily inoculated with *Bacillus larvae*. This honey solution was made by thinning honey with warm water and adding an ample supply of the diseased bee larvae in the ropy and scale stages. The inoculated solution was brushed over the wire screening covering the top of each nucleus. This process was repeated until the bees had become gorged with the diseased honey solution. Then the nuclei hives were taken to their permanent locations in the experimental apiary.

The field data collected during the two years of investigation have been arranged in tabular form. See Table 2.

TABLE 2

Method of treating colonies	1931—Field Results						1932—Field Results						Total	
	Series I natural		Series II starving		Series III feeding		Series I natural		Series II starving		Series III feeding			
	No. colonies treated	No. developing A. F. B.	No. colonies treated	No. developing A. F. B.	No. colonies treated	No. developing A. F. B.	No. colonies treated	No. developing A. F. B.	No. colonies treated	No. developing A. F. B.	No. colonies treated	No. developing A. F. B.	No. colonies treated 1931–1932	No. developing A. F. B. 1931–1932
Empty hive.	3	0	3	1	3	0	3	0	3	0	3	0	18	1
Foundation	3	0	3	1	3	0	3	0	3	0	3	0	18	1
Foundation plus comb	3	1[1]	3	0	2	0	3[2]	0	3	0	3[3]	1	17	2
Drawn combs....	3	1	3	0	3	2	3	1	3	1	3	3	18	8

[1]Comb removed at end of 163 hours.
[2]Practically all combs in this method were removed at the end of 36 hours except [1] and [3].
[3]Comb removed at end of 120 hours.

LABORATORY PROCEDURE.—The honey solution used in Series III—Feeding was checked in the laboratory for the presence of *Bacillus larvae* by diluting the solution (2 parts honey solution to 8 parts water), centrifuging thirty minutes at 2,000 revolutions per minute, then plating. All plates revealed an abundance of *Bacillus larvae*.

At the end of the field work, material was taken from each nucleus. Each random sample taken from the nucleus was composed of comb, pollen, and honey taken from various locations within the brood nest. Each sample was put in sterile water, and allowed to remain there for twenty-four hours, then filtered through coarse filter paper, centrifuged and plates inoculated with the filtrate. Pure cultures were made from the plates containing *Bacillus larvae*. To further prove the above organisms were *Bacillus larvae*, some sugar syrup (one part sugar to two parts water) was heavily inoculated with these organisms and fed back to some healthy honey bee larvae. These different inoculated sugar syrup solutions all resulted in diseased larvae and the subsequent recovery of the organism, *Bacillus larvae*. See Table 3.

TABLE 3

Method of treating colonies	1931—Laboratory Results						1932—Laboratory Results						Total	
	Series I natural		Series II starving		Series III feeding		Series I natural		Series II starving		Series III feeding			
	Colonies sampled	Colonies showing Bacillus larvae	Colonies sampled	Colonies showing Bacillus larvae	Colonies sampled	Colonies showing Bacillus larvae	Colonies sampled	Colonies showing Bacillus larvae	Colonies sampled	Colonies showing Bacillus larvae	Colonies sampled	Colonies showing Bacillus larvae	No. colonies sampled 1931–1932	No. colonies showing Bacillus larvae 1931–1932
Empty hive	1	0	3	1	3	0	3	0	3	0	3	0	16	1
Foundation	1	0	3	2	1	0	3	0	3	0	3	0	14	2
Foundation plus comb	–	–	3	0	2	0	3	0	3	0	3	1	14	1
Drawn combs....	2	2	3	0	2	1	3	1	3	1	3	3	14	8

DISCUSSION.—In checking over the data, it would seem that the results obtained in 1932 would be much more authentic than those obtained in 1931, since during the first season, there were various phases in the technique that had to be worked out and a certain amount of proficiency attained before the application of the technique could be efficiently applied.

The records taken on the diseased colonies treated show that in all cases the percentage of diseased brood in every colony was 25% or over, except in one case where a colony had a 10% infection.

While it would have been preferable if data could have been kept on each treated colony over a period of two years, nevertheless the results covering one season should be very authentic. This is especially true since practically all the colonies treated during the experiment were at the point of starvation in late fall which would mean that they had consumed practically all the honey in the hive.

Field Results: In treating diseased colonies by the empty hive method, eighteen empty hives were used, of which only one showed a reoccurrence of the disease. The writers feel that this single case of reoccurrence was due probably to some faulty step in the technique since the case of reoccurrence developed during the first season of the experiment. This explanation seems even more probable because the empty hive was in Series II—Starving, where the least amount of honey would have been carried over from the diseased hive to the new empty hive. The most outstanding thing about the empty hive method was that in Series III, where the bees gorged themselves with a sugar syrup heavily inoculated with *Bacillus larvae,* there was no reoccurrence of the disease.

In the method where full sheets of foundation were employed, the data gathered during the two seasons show, that of the eighteen colonies treated, there was only one reoccurrence of disease (1931—Series II). Here again since the colony was in Series II—Starving, the authors think that the single case of reoccurrence might be attributed to some faulty step in the technique. The fact is very significant that in Series III—Feeding, by the Foundation Method, there was no reoccurrence of the disease although the chances that there would be diseased honey available for use in brood rearing would seem to be greater than in the empty hive method.

Of the 18 colonies treated by the method where full sheets of foundation and one drawn comb were employed, there were only two reoccurrences of disease. These occurred in colonies in Series I—Natural Shaking and in Series III—Feeding. The field data show that the frames of drawn comb had been left in the hive for 163 hours in one case and for 120 hours in the other case, before removing them from the hive, which well explains why disease might reoccur. Drawing from a general knowledge of bee behavior and applying it to this method where foundation and drawn comb were used, the interval that the drawn comb should be left in the hive should not be less than twenty-four hours, or more than thirty-six hours, if the comb is to serve its purpose—that of a "trap" for the diseased honey. As the time interval over the maximum period (thirty-six hours) becomes greater, the chances become increasingly greater for the transfer of the diseased honey from the drawn comb to the newly drawn out sheets of foundation.

The results of the drawn comb method were most enlightening and emphasized the fact that the amount of diseased honey carried over to the new brood nest is one of the most determining factors in bringing about a reoccurrence of the disease. Of the 18 hives treated by this

method there were eight reoccurrences of disease. In the starvation series, during the two years, there was only one case of disease in the six colonies treated; in this series there would be the least amount of diseased honey deposited in the new brood nest of any of the series in which the drawn comb method was used. In the series where natural shaking was used, there were, during the two years of the experiment, two cases of disease in the six colonies treated. As the series indicates, there would be more diseased honey carried over in natural shaking than in the starvation series. In the feeding series, during the two years of the experiment, five out of six colonies treated showed a reoccurrence of the disease. It is self-evident that in each of the Series, Starvation, Natural Shaking and Feeding, there were varying amounts of diseased honey carried over into the new brood nest, yet of the eighteen colonies treated ten showed no reoccurrence of the disease. These results might be explained by applying the dispersion theory, i. e., if nectar is being brought in from the field, there is a constant manipulalation of the nectar with the honey in the open cells of the brood nest or supers which results in the dispersion of the spores in the diseased honey. If the dispersion of the spores in the honey should reach the point where there are less than 10,000,000 spores of *Bacillus larvae* to every 0.01 cc. of honey it would be impossible for the bee larva to receive a lethal dose because of the resistance of the larva against the organism.

Laboratory Results: The bacteriological work confirmed the field diagnosis in every case where checked; that is to say, wherever American foulbrood was identified in the field by its physical characteristics, such material when smeared on slides and examined under an oil immersion lens, showed the presence of *Bacillus larvae*.

As will be noted from Table 3, the bacteriological check against all colonies treated in the field work was incomplete. This occurred during the first year of the experiment when much of the technique was being worked out.

There was one case where a nucleus showed the presence of *Bacillus larvae* when field diagnosis failed to show any abnormality of the brood (1931—Series II, Foundation method).

No doubt some criticism will be made of the random sample procedure. The writers admit it is not an absolute indication that no *Bacillus larvae* existed in the disease-free nuclei, but nevertheless, it is a fairly accurate check that such was the case.

Conclusions

1. The Field results checked with the Bacteriological results with a high degree of accuracy.

2. The greater the amount of honey that the bees carry over from the diseased hive to the new hive, the greater the chances of an occurrence of American foulbrood.

3. The greater the interval between shaking the bees from a diseased colony and the time when the bees have cells in which to store honey, the less the chances for a reoccurrence of the disease.

4. It is very important that the diseased material from shaken colonies be given immediate and prompt disposition.

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THE WEIGHT PER GALLON OF HONEYS FROM VARIOUS FLORAL SOURCES

By Geo. E. Marvin, *Assistant Apiculturist, Bureau of Entomology, United States Department of Agriculture*

The weights per gallon of 40 samples of honey from various floral sources produced in different parts of the United States have been determined. The samples of honey from tulip poplar and locust were produced at Somerset, Md., samples from Wyoming, Louisiana, and California were contributed by the Federal bee culture field laboratories in these States, and the other samples were purchased from beekeepers. All the honeys were presumably marketable and their plant sources were given by the persons producing them.

Methods Used.—The weight per gallon of each sample of honey was obtained by two methods, by direct weighing and by means of a refractometer.

The direct-weighing method consists of filling a standard measure with honey, finding its net weight, and calculating the weight per gallon. The honeys that were granulated when received were first liquefied in a water bath at 140° F. (60° C.). The filling of the standard measure and the weighing were done at a temperature of 68° F. (20° C.). Any air bubbles incorporated during the pouring were brought to the surface by subjecting the measure containing the honey to a vacuum of approximately 20 inches and then removed with a spoon. The air bubbles will also rise to the top if the honey is allowed to remain in the measure overnight. More honey was added to fill the measure, and the surplus was smoothed off with a glass plate.

The refractometer method consists in determining the refractive index of the honey in the manner usual with this instrument and finding the equivalent weight per gallon from a table that has been prepared for this purpose. Water at 68° F. (20° C.) is circulated through the prisms of the refractometer to avoid the necessity of making temperature corrections, and the prisms are cleaned and dried before each charge of honey.

Results.—The results of these tests are summarized in Table 1. It will be seen that there is very little difference between the weights obtained by the two methods, and that those obtained by the refractometer are usually a little higher. The refractometer method is considered to be the most accurate, however, because of the greater precision of the instrument, and it has the further advantages of being more rapid and

permitting the use of a much smaller sample. In discussing the relative weights per gallon of the honeys listed in Table 1, therefore, those obtained by the refractometer method are used.

TABLE 1. WEIGHT PER GALLON OF HONEYS FROM VARIOUS FLORAL SOURCES, AS DETERMINED BY DIRECT WEIGHING AND THE REFRACTOMETER METHOD

Laboratory number of honey	Year produced	Floral source	Producing area	Weight per gallon as determined by—	
				Direct weighing	Refractometer
				Pounds	*Pounds*
1093	1930	Star-thistle	California	11.880	11.895
1094	1930	Gallberry	South Carolina	11.824	11.828
1097	1931	Catclaw	Arizona	11.922	11.929
1098	1931	White clover	Louisiana	11.824	11.839
1099	1931	Tupelo	Louisiana	11.767	11.779
1113	1931	Peppervine	Louisiana	11.697	11.706
1121	1931	Goldenrod	Louisiana	11.760	11.762
1130	1931	Fireweed	Oregon	11.911	11.901
1131	1931	Star-thistle	California	11.909	11.895
1133	1931	Sourwood	Virginia	11.816	11.795
1134	1931	Sumac	Connecticut	11.816	11.795
1135	1931	Goldenrod	Ohio	11.802	11.779
1138	1931	Buckwheat	Ohio	11.760	11.765
1139	1931	Alfalfa	Nevada	11.990	11.963
1141	1930	Sweetclover-alfalfa	Wyoming	11.972	11.997
1152	1931	Alfalfa-sweetclover	Montana	11.937	11.957
1153	1931	Sweetclover	Colorado	11.881	11.906
1160	1931	White clover	Ohio	11.780	11.817
1187	1932	Goldenrod	Louisiana	11.689	11.695
1194	1932	Sage	California	11.831	11.845
1201	1932	Eriogonum	California	11.943	11.957
1202	1932	Creosote bush	California	11.887	11.915
1203	1932	Athel	California	11.902	11.934
1207	1932	Tupelo	Florida	11.802	11.828
1210	1931	Buckeye	California	11.852	11.839
1211	1932	Tulip poplar	Maryland	11.831	11.845
1212	1932	Locust-tulip poplar	Maryland	11.852	11.856
1213	1931	White clover	Ohio	11.781	11.795
1214	1932	Sweetclover	Wyoming	11.993	11.986
1219	1932	Basswood	Wisconsin	11.866	11.867
1220	1932	Palmetto-mangrove	Florida	11.739	11.745
1222	1932	Fireweed	Washington	11.852	11.846
1226	1933	Orange	California	11.725	11.739
1228	1933	White clover	Ohio	11.849	11.855
1235	1933	Sweetclover	Wyoming	11.913	11.925
1236	1932	White clover	Ohio	11.746	11.759
1238	1933	Tulip poplar	Maryland	11.795	11.779
1239	1933	Locust	Maryland	11.717	11.747
1240	1933	Locust-tulip poplar	Maryland	11.731	11.771
1244	1933	Raspberry	Michigan	11.795	11.815

Not one sample weighed as much as 12 pounds per gallon, the figure which formerly was considered the minimum weight per gallon for a well-ripened honey. This study of 40 samples corroborates earlier experiments, covering a longer period, which led to the decision to place the

minimum weight specifications in the United States grades for honey at 11.75 pounds per gallon of 231 cubic inches at 68° F. (20° C.).

The two heaviest honeys were found to be sweetclover-alfalfa and sweetclover from Wyoming, weighing, respectively, 11.997 and 11.986 pounds per gallon. The two lightest honeys were goldenrod and pepper-vine from Louisiana, weighing, respectively, 11.695 and 11.706 pounds per gallon.

Honeys from the same floral sources but produced in different sections of the country showed little variation. In 5 samples of white-clover honey, 4 from Ohio and 1 from Louisiana, the range was from 11.759 to 11.855 pounds per gallon. Similar results were shown between samples of goldenrod honey from Louisiana and Ohio, between samples of sweetclover honey from Colorado and Wyoming, and of tupelo honey from Florida and Louisiana.

For convenience the honeys have been divided into four classes according to weight per gallon, as follows: (1) Those weighing 11.880 pounds per gallon or above, (2) those weighing from 11,800 to 11,880 pounds per gallon, (3) those weghing from 11.750 to 11.800 pounds per gallon, and (4) those weighing less than 11.750 pounds per gallon.

Thirteen samples, or 32.5 percent of the honeys examined, weighed 11.880 pounds per gallon or above. These honeys were obtained from the following floral sources: 3 from sweetclover, 1 from alfalfa, 2 from a mixture of sweetclover and alfalfa, 2 from star-thistle, and 1 each from catclaw, fireweed, Eriogonum (wild buckwheat), creosote bush, and athel (Tamarix). Five of these honeys originated in California, 3 in Wyoming, and one each in Arizona, Colorado, Montana, Nevada, and Oregon.

Twelve samples,or 30.0 per cent of the honeys examined, weighed from 11.800 to 11.880 pounds per gallon. These honeys were obtained from the following floral sources: 3 from white clover, and 1 sample each from gallberry, sage, tupelo, buckeye, tulip poplar, locust-tulip poplar, basswood, fireweed, and raspberry. Two honeys each originated from Ohio, California, and Maryland, and one each from South Carolina, Louisiana, Florida, Wisconsin, Washington, and Michigan.

Ten samples, or 25 per cent of the honeys examined, weighed from 11.750 to 11.800 pounds per gallon. These honeys were obtained from the following floral sources: 2 from white clover and goldenrod, and 1 each from tupelo, sourwood, sumac, buckwheat, tulip poplar, and locust-tulip poplar. Four of the honeys originated in Ohio, 2 each in Louisiana and Maryland, and 1 each in Virginia and Connecticut.

Five samples, or 12.5 per cent of the honeys examined, weighed less

than 11.750 pounds per gallon. The floral sources were peppervine, goldenrod, palmetto-mangrove, orange, and locust. Two of the honeys originated in Louisiana, 1 in Maryland, and 1 each in Florida and California.

CONCLUSION. From these results it is obvious that the heavier honeys are produced in the more arid sections of the United States, and that there is little variation in weight between honeys from the same floral source but produced in different sections of the country.

THE NET WEIGHT OF COMBLESS PACKAGES OF HONEYBEES FROM THE SOUTH

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The development of the package bee industry has resulted in considerable progress in the methods of handling and shipping package bees. Through the adoption of similar shipping cages, the general use of sugar syrup as food and efficiency in transportation, the losses in transit have been greatly reduced.

In the three years, 1931–1933, thirty-nine packages of bees were received from southern shippers. These bees were received by the two authors at two widely separated points and should be fairly representative of package bees on arrival at northern points. The net weight of bees in each package at the time of arrival is given in Table 1. These data show that the variation in the net weights of the indivadual packages is greater than is desirable. With the exception of one 3-pound package which contained two pounds, nine ounces of bees, all of the packages were in excellent condition at the time of arrival, only a small number of dead bees being present in the cages. In the case of the 3-pound packages the net weight of bees varied from two pounds, seven ounces, to three pounds, eleven ounces, or a variation of one pound, four ounces. The 4-pound packages were all short in weight and the variation was fifteen ounces. The 5-pound packages varied in weight of bees from four pounds, two ounces, to five pounds, five ounces, or a variation of one pound, three ounces. Similar variations were noted by Nolan (1932) in package bees received in 1927.

From the standpoint of either the beekeeper who is using package bees for honey production or the orchardist who is using the bees for pollination purposes, a uniform number of bees per pound is desirable

TABLE 1. NET WEIGHT OF BEES IN COMBLESS PACKAGES WHEN RECEIVED FROM SOUTHERN SHIPPERS DURING 1931, 1932, AND 1933

3-pound packages	Pounds	Ounces
Shipper A		
	3	2
	2	15
	3	5
	2	9
	3	3
	3	10
	3	4
	2	14
	3	0
	2	9
	3	7
	2	7
	2	15
	2	13
	2	7
	2	13
	3	1
	3	2
	3	2
	3	0
Weight received	59	10
Weight ordered	60	0
Shipper B	3	0
	2	7
Weight received	5	7
Weight ordered	6	0
	3	7
Shipper C	3	11
Weight received	7	2
Weight ordered	6	0

4-pound packages	Pounds	Ounces
Shipper A		
	3	8
	3	2
	3	5
	2	9
Weight received	12	8
Weight ordered	16	0

5-pound packages	Pounds	Ounces
Shipper A	4	2
	4	7
	4	3
	4	12
	4	10
	5	5
	4	14
	4	10
	4	5
Weight received	41	4
Weight ordered	45	0
Shipper D	4	14
	5	1
	4	12
	5	0
Weight received	19	11
Weight ordered	20	0

in each package. Under certain conditions a 3-pound package of bees may develop into a satisfactory colony while under the same conditions a package containing two pounds, seven ounces of bees may be much less valuable for honey production. In the case of the orchardist who uses package bees for pollination, the packages should have sufficient uniformity to permit regular distribution in the orchard without the necessity of setting weaker packages closer together or of placing the stronger ones farther apart. It is doubtful if many of the northern buyers will attempt to equalize the number of bees in the packages.

Table 2 shows the total weights of bees ordered and the total weights of bees received in packages of different sizes. The 3-pound packages were slightly overweight, while the 4-pound and 5-pound packages were

DIFFERENT SIZED PACKAGES

TABLE 2. TOTAL NET WEIGHTS OF BEES ORDERED AND TOTAL NET WEIGHTS OF BEES RECEIVED

Size of package	Total weight of bees ordered	Total weight of bees received	Per cent overweight	Per cent underweight
3-pound	72 lbs. 0 oz.	72 lbs. 3 oz.	0.26	
4-pound	16 lbs. 0 oz.	12 lbs. 8 oz.		21.88
5-pound	65 lbs. 0 oz.	60 lbs. 15 oz.		6.25
All sizes	153 lbs. 0 oz.	145 lbs. 10 oz.		4.82

underweight. When weights of packages from the different shippers is examined (Table 3) it is noticed that the total weight of bees received from three of the four shippers was less than ordered. It is not believed that the underweight was intentional on the part of the shippers but that the shortage was due to lack of information as to how many bees it is necessary to place in a cage to insure full weight at destination. Table 3 also shows that the total poundage of bees received from all shippers was about 5 per cent less than ordered. Nolan states that although individual packages varied in weight, the total poundage received was about 2 per cent above the weight of bees ordered.

DIFFERENT SHIPPERS

TABLE 3. TOTAL NET WEIGHTS OF BEES ORDERED AND TOTAL NET WEIGHTS OF BEES RECEIVED

Shipper	Total weight of bees ordered	Total weight of bees received	Per cent overweight	Per cent underweight
A	121 lbs. 0 oz.	113 lbs. 6 oz.		6.30
B	6 lbs. 0 oz.	5 lbs. 7 oz.		9.38
C	6 lbs. 0 oz.	7 lbs. 2 oz.	18.75	
D	20 lbs. 0 oz.	19 lbs. 11 oz.		1.56
All	153 lbs. 0 oz.	145 lbs. 10 oz.		4.82

Nolan has shown that nearly one-third of the weight of the bees in the packages on arrival may be due to sugar syrup. He brings out the point that this may be attributed to the taking of an excess amount of food during transit or to the excess of food taken up by the bees when the packages are filled. To get a comparative measure of the actual number of bees in the packages, twenty-two packages of bees were fed liberally by painting the screen of the shipping cages with syrup until the bees would take no more food. The same was done with three packages of bees shaken from colonies in a northern apiary and fed immediately. The packages shipped from the South gained in weight by feeding 20.70% and the packages from the northern apiary gained 25.17%. This indicates that the bees in the packages when received

from the South were carrying in their bodies a larger amount of food than were the bees in the hives and that there were actually less bees in the packages than their net weight indicated. It is probable that the bees shaken from the three colonies mentioned would have gained in weight more than 25.17% if it had been possible to remove them from the combs without disturbance.

Some package-bee shippers drum bees into boxes placed at the top of hives while others shake bees from the combs at different times of day or when different proportions of bees of various ages are in the hive. Some shake bees from the brood-nest while others shake from supers. Doubtless some operators disorganize the colonies from which the bees are being removed more than others, resulting in variation in the amount of honey taken up by the bees. Some shippers feed colonies while bees are being removed for shipment, which might cause variation in the weight of individual bees. Discrepancies in the size or number of holes in the feeders may easily account for increase or decrease in weight of bees on arrival. All of these variables must result in discrepancies in the age combinations or weights of bees in packages, resulting in differences in their value to the northern receiver. It would seem desirable for investigations to be conducted in cooperation with the package bee shippers in developing a standard and more uniform method of weighing bees into shipping cages so that when the packages arrive at their northern destination the beekeeper would be assured of packages ot proper weight.

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SPRAY POISON IN THE YAKIMA VALLEY

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Beekeepers of the Yakima Valley have contended with spray poisoning for years, but the source of the poison has been from fruit trees. Because of the necessity for heavy applications of lead arsenate throughout the season, any apiary within bee flight of sprayed orchards was more or less subject to poisoning. The situation was acute, especially in the lower valley in the vicinity of Prosser, where in some orchards the spray rig is at work practically all day during the summer and as many as eight and ten cover sprays are applied.

The Yakima Valley differs from the Wenatchee Valley in particular

on account of its breadth and diversity of crops. Because of the large areas in the Yakima Valley devoted to alfalfa and potatoes it has been possible for commercial beekeepers to move their yards some distance away from the source of spray poison in the fruit district. On this account, losses have been greatly reduced in recent years.

In 1933 for the first time it became necessary to spray for the Colorado potato beetle on a large scale. Although the insect has occurred in the Yakima Valley for five or six years, it had not been necessary until this year to utilize any special widespread treatment with insecticides. This general spraying has resulted in heavy losses in numbers of colonies and in reduction of the honey crop.

While the census figures for 1930 indicate only 3691 colonies of bees in Yakima County, the estimate of our Deputy Bee Inspector for that county is approximately 10,000. As a matter of fact, in 1932 more than 8,000 colonies were actually examined in the course of the bee inspection work.

An estimate by Mr. W. C. Wixom, Yakima County bee inspector, indicates that the actual loss in the county in 1933 is approximately 2,000 colonies. At the annual meeting of the Washington State Beekeepers Association, Mr. Wixom stated that very likely another thousand colonies will be lost during the winter on account of insufficient stores. On occasion, losses have run as high as 50 per cent of the total number of colonies.

In pounds of honey, the loss is more difficult to measure, since much of the alfalfa was killed out last year and during the winter. A second factor was the long period in spring when bees did not leave the hive because of cold and cloudy weather, which resulted in a high consumption of stores and in the starvation or weakening of many colonies. A loss of some 600,000 pounds of honey for the Yakima Valley this year is given as a conservative estimate.

As indicated in Figure 65, the district where fruit trees are grown does not cover the entire area. The black squares, which indicate the distribution of various bee yards in this section of the Yakima Valley, are located in an area devoted largely to growing potatoes and alfalfa. In fact, beekeepers have been forced out of the fruit areas to a large extent in order to get away from the spray poison in the first place. This year some beekeepers have preferred to move back into the orchard district late in the season after orchard spraying had ceased rather than to leave them in the potato district, believing such a location to be the lesser of the two evils.

According to reports, some of the potato growers have made as many as six to eight applications of lead arsenate at the rate of three or four pounds to 100 gallons in order to control the Colorado beetle. Potato fields which were not sprayed were on occasion entirely stripped of foliage.

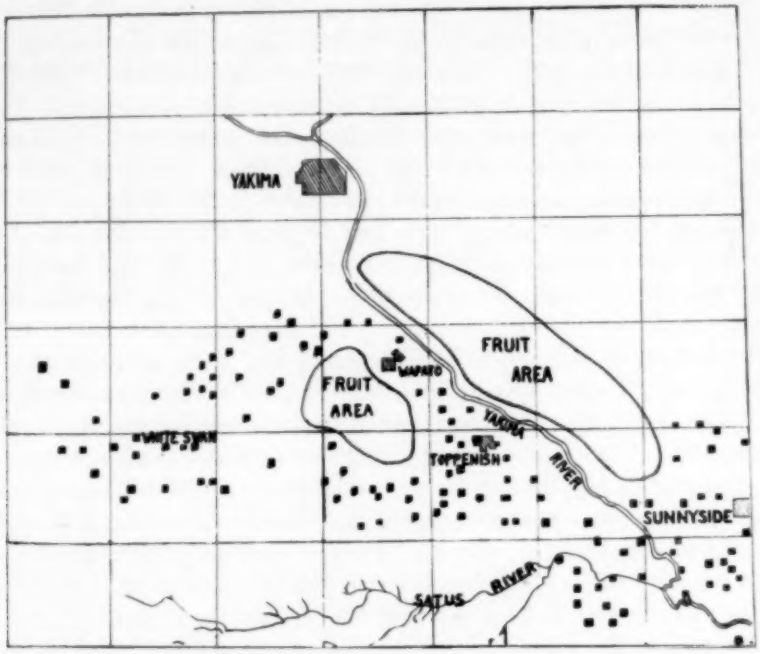

FIG. 65.—Location of apiaries in Yakima County, Washington, where bees suffered heavy losses from spray poison. The source of the poison was potatoes sprayed with lead arsenate rather than fruit trees, which were also heavily sprayed.

MOVING AWAY FROM POISONING.—Some beekeepers, fearing heavy losses from arsenical poison, moved bees entirely out of the alfalfa and potato district into adjoining sagebrush areas, even into the orchard districts. Where bees were moved into the sagebrush area, there was a greater concentration of the poisoning due to the fact that the bees were limited to areas only in one direction, while in the potato district the bees had access to fields on all four sides of the yard. Losses were much heavier in such cases than in the potato district itself.

In one case, a yard which had been moved into the sagebrush contained 116 colonies early in August. About the first of September the total number of colonies had dropped to 75, a loss of 41 colonies in a

little more than a month's time. The remaining colonies did not have sufficient stores to keep them over the winter, and many of them had to be doubled up. This yard represents practically a total loss to the beekeeper.

Moving into the orchard districts after the spray season did not result in any measurable gains as compared to those yards that remained in the alfalfa and potato districts. In another case where the bees were moved into the orchard, the actual loss was much less than in the yard just mentioned. Moving into the orchard resulted in a loss of only 14 colonies, and the general condition of the yard was much better, the living colonies being stronger and containing possibly half again as much honey as the first yard.

METHOD OF POISONING.—In the daily poisoning, the morning seems to be the time of the heaviest losses of bees. This can be attributed to one thing: the flowers not being open in the early morning, the bees go to the dew and water on potatoes and alfalfa plants and being particularly attracted to the lead arsenate spray they take up this water and carry it back to the hive. As a result, the bees die within a few hours, and in some cases even the young brood is killed off.

In some instances pollen has carried the arsenical poison where a great deal of dusting has been done to kill the insect, the bees picking up the grains and packing them back to the hive. This of course represents a loss not only to the older bees but also to the younger bees. These seem to be the two chief methods of the poisoning of bees in this area.

POSSIBLE MEASURES FOR RELIEF.—So far as can be learned, lead arsenate has been used entirely in the spraying operations to check the insect. The reason for this is because this arsenical is used on such a large scale on apple trees for codling moth control. In discussing possible means of reducing losses by spray poison, it has been suggested that calcium arsenate, zinc arsenite, or Paris Green be utilized in place of the lead arsenate. It seems likely that lead arsenate has in itself some property which may attract the bees to it. Beekeeping in eastern Colorado, where calcium arsenate is largely used for control of biting insects on potatoes, does not seem to have been accompanied by extensive losses to the colonies. So far we have no tangible evidence which would warrant this definite conclusion, but this may be a way out of the difficulty. Possibly the substitution of one of the fluorine compounds would avoid these heavy losses.

As the matter stands at present, Yakima beekeepers are looking for locations in other parts of the state or even in other states in order to avoid these heavy losses.

A METHOD FOR MEASURING RELATIVE HUMIDITY BY MEANS OF THERMOCOUPLES

By A. W. Woodrow,[1] *New York State College of Agriculture, Ithaca, New York*

In biological research on the effects of temperature and relative humidity on the activities of experimental animals, one of the difficulties often encountered lies in the determination of relative humidity in confined spaces. Of the several methods of measurement of relative humidity, the most accurate results are obtained through the proper operation of the sling psychrometer, but it is not adapted to all types of work, particularly in restricted spaces. Likewise, other methods of measurement often are not adaptable and many of them are inaccurate. In some work recently undertaken it was necessary to measure accurately the relative humidities in a series of incubators, each of about 50 dm. capacity. It is found that by the use of thermocouples relative humidity determinations can be made with an accuracy equal to that obtained through the use of the sling psychrometer.

Apparently the only similar use of thermocouples in the determination of relative humidity is that described by Lanning (1932). He reports the use of a wet thermal junction made by suspending a drop of water in a small coil formed of the thermocouple wires at one junction and measuring the potential differences between that and the second junction at air temperature. He states, "this voltage difference, when calculated to degrees Fahrenheit, is not the same as the temperature difference shown by the wet- and dry-bulb thermometers but is always lower." Lanning found it necessary to construct a curve according to his own calibration which was made by observing the potential differences over solutions of sulfuric acid made up to strengths which should give definite relative humidities. It presumably would be necessary to recalibrate for each new instrument and also perhaps each time that any one system was used in a different situation.

In the method here described, wet- and dry-bulb temperatures are measured by substituting copper-constantan thermocouples for mercurial thermometers and the relative humidities are calculated according to standard hygrometric tables. The dry-bulb temperature is measured in the usual way by suspending a bare thermal junction in the air and a small wick is formed about the thermal junction which serves as the wet-bulb. The wick is made of good quality old cotton broadcloth which has

[1]The author is indebted to Professor E. F. Phillips for suggesting the method described here and for his advice and assistance in the preparation of this paper.

been laundered several times. Other materials which have been tried as wicks are rayon, silk and linen fabrics of several kinds. The first two do not absorb water readily enough and although linen is one of the most absorbent types of cloth, it tends to dry-out quickly and does not hold an adequate quantity of water on the surface to permit maximum evaporation. The use of the materials tested, other than cotton cloth, resulted in less reduction of temperature of the wet-bulb than occurs with the use of the wet-bulb thermometer.

In the construction of the wick one thickness of the cloth is sewed about one wire and then the other in such a way that they are covered in a roll of cloth about one and one-half to two millimeters in diameter and for a distance of about fifteen millimeters from the thermal junction. The cloth is also rolled and sewed about the thermal junction and extends beyond it approximately two millimeters so as to cover the thermal junction completely. Best results are obtained when the thread and the cloth are not drawn tightly. If the wick is not made properly or is improperly proportioned, maximum ovaporation will not be attained.

For use in testing the efficiency of an instrument or for use in a cabinet or room where a fan may be used, the wick may be extended two or three centimeters from the thermal junction into a reservoir of distilled water as is done in the case of the Mason hygrometer. The wick is wet thoroughly by applying distilled water to one end and allowing it to wet the wick by capillarity thus facilitating the exclusion of air. Air included in the wick or an incomplete wetting of the fibers causes a serious error in the results obtained. For the measurement of relative humidity in incubators, in which a fan cannot be used, or in chambers through which air is circulated, a glass tube was devised (Fig. 66) which holds the wet thermal junction. By means of a vacuum pump, adjusted to remove air at a definite rate, sufficient air is drawn through the tube to give a rate of movement of air past the wick in excess of three meters per second. By correct size and shape of the tube and correct placing of the wick, the temperature of the wet thermal junction is reduced to that of a wet-bulb thermometer in approximately twenty-five seconds. Although this removes about one-half liter or one per cent of the air from the incubator, it does not affect appreciably the relative humidity of an incubator of fifty dm. capacity, at least during the period of measurement.

It seems important that the wick in the psychrometer tube be in a vertical position, the thermal junction being at the lower point. The reason for this is not apparent but may be due to the fact that this position allows additional moisture to flow down about the thermal junction as evaporation tends to dry the wick. The wick is wet before

each determination and the excess water removed by touching the end of the wick lightly on filter paper. The wire leads from the thermal junction are attached to a glass rod passed through a stopper, the uppermost end of the wick being about two centimeters from the end of the rod so that the rod will not affect the direction of the air currents or the temperature of the wick. The glass rod bearing the thermal junction is inserted into the psychrometer tube in such a manner that the wick is in the center of the tube with no part touching the sides. If the wick touches the sides of the tube, incorrect readings will result. The wet thermal junction is placed at the point where the most rapid and maximum cooling result when the air is drawn through the tube. This may be determined by a few tests in different positions. If these conditions are correctly provided, the temperature of the wet thermal junction becomes the same as that of the wet bulb thermometer. The psychrometer tube with the wet thermal junction in place is inserted into the top of the incubator through an opening made for that purpose. A dry thermal junction is placed permanently in the incubator.

The reduction in pressure necessary to cause sufficient air to flow past the wet thermal junction is about three millimeters of mercury, which, although easily computed, is practically negligible from the standpoint of its effect on the rate of evaporation. Since most incubators are not entirely air tight, the removal of air from them at this rate affects neither the pressure within the incubator nor the amount of suction necessary to remove the air. If appreciable reductions in pressure are encountered they must be considered in the calculations of the relative humidity. A manometer attached to the air line near the psychrometer tube is useful in determining the amount of reduction in pressure.

To test the accuracy of the method a large number of comparisons were made with the wet- and dry-bulb psychrometer. A bare thermal junction, a wet one with the wick extending into a reservoir of distilled water, a wet one within the psychrometer tube and a new sling psychrometer were placed as closely together as practicable in a small room. A fan of high velocity was placed so as to fan them equally and another fan was used to circulate the air in the room to keep it as nearly uniform as possible. The accompanying table (Table 1) gives some of the results obtained when the three were read as nearly simultaneously as possible. The sling psychrometer wick was wet and allowed to come to equilibrium each time before the readings were taken. . In the records of the sling psychrometer the averages of two readings is given in each case and calibration corrections have been made. The records for the fanned wet thermal junction with reservoir also are averages of two ob-

servations made alternately with those of the other instruments. This was done to reduce as much as possible the effect of lag on the sling psychrometer when the relative humidity is fluctuating. To conserve space the temperature records of the dry-bulb thermometer are omitted. These agree with the dry thermal junction records of Table 1 as closely as could be expected under conditions of slightly fluctuating temperatures. The significant figures are the temperatures of the wet-bulb obtained by the different methods.

TABLE 1. COMPARABLE READINGS OBTAINED WITH WET-BULB OF SLING PSYCHROMETER, WITH WET-THERMAL JUNCTION INSIDE AND OUTSIDE PSYCHROMETER TUBE

Temperature air (dry thermal junction) F°	Sling psychrometer wet-bulb temperature F°	Fanned wet-thermal junction temperature F°	Psychrometer tube wet-thermal junction temperature F°	
70.15	54.10	54.00	54.25	
70.95	54.40	54.55	54.70	
70.80	54.80	54.70	54.75	Comparatively
70.80	54.80	54.80	54.85	Low
71.30	55.25	55.25	55.30	Relative
71.30	55.55	55.60	55.55	Humidity
72.60	56.25	56.20	55.10	
72.65	56.30	56.30	56.55	
68.00	54.45	54.70	54.75	
68.80	55.25	55.15	55.35	
69.25	55.55	55.55	56.60	Medium
69.55	55.90	55.65	56.00	Relative
69.90	56.18	55.85	56.10	Humidity
69.70	56.45	56.35	56.20	
70.15	56.65	56.55	56.55	
70.15	56.70	56.65	56.55	
73.95	67.30	67.40	67.40	
74.20	67.45	67.40	67.30	
74.40	66.15	65.90	65.90	Comparatively
74.90	66.20	66.05	66.00	High
74.90	65.95	66.00	65.75	Relative
75.10	67.85	67.80	67.85	Humidity
74.95	68.55	68.65	68.55	
75.15	68.50	68.65	68.40	
75.15	68.75	68.95	68.80	

The records given for the wet-bulb of the sling psychrometer would be reduced slightly if allowance had been made for stem correction. In the use of the sling psychrometer, however, stem correction is not ordinarily considered. Owing to the fact that the sling psychrometer used was graduated only to 0.50° Fahrenheit, the accuracy of the figures following the decimal point is not high but is dependent upon the judgment of the observer. Even in a small room, temperature and relative

humidity at different points vary, causing continual fluctuations in the readings obtained. The lag in a mercurial thermometer is much greater than that of thermocouples and it is to be expected that the readings will disagree slightly. When the records given in Table 1 were taken, temperature and relative humidity were rising and, in most cases, it is likely that the temperatures recorded for the sling psychrometer are slightly low while those of the thermocouples are more nearly accurate due to their more rapid response to temperature changes. When calculations of relative humidities from the figures in Table 1 are made the slight differences in the results given by the different methods of measurement disappear.

It might have been desirable to have records covering a wider range of relative humidities than those of Table 1 but, in view of the close agreement of these results, it appears unnecessary. It seems that since the results of the thermocouples agree almost exactly with those of the sling psychrometer over a considerable range of relative humidity, they will agree at all relative humidities. This assumption appears tenable since the agreement is equally good at comparatively low relative humidities. At low relative humidities where the differences in temperature between the wet- and dry-bulbs are larger, discrepancies between the results of the two methods would be greater.

If the temperature of the air which is being measured for relative humidity becomes changed during the process of drawing it through the psychrometer tube, calculations may be made to correct for this, but it is desirable to measure the relative humidity as near to the location of the sampled air as possible without drawing it through lengths of glass tubing which change its water content. It is to avoid this difficulty that the psychrometer tube is inserted directly into the incubator.

Several precautions must be taken in the use of the method. It is, of course, necessary to keep the wicks clean, as soiled wicks prevent maximum evaporation. Cleaning may sometimes be done by thoroughly syringing the wick with alcohol after which time must be allowed for complete evaporation of the alcohol. The wicks should be tested from time to time to see if they are functioning properly. Care should be taken to see that the wick is maintained in the proper position in the psychrometer tube. The frequent handling necessary in making the observations may cause modifications of position which will result in inaccurate readings. To insure accuracy in the determination of the relative humidity sufficient time should be allowed, after the psychrometer tube is inserted into the incubator, for the walls of the psychrometer tube to come to the same temperature as that of the air inside the incubator.

It is difficult to give exact specifications on the size and shape of the psychrometer tube which will result in the most rapid cooling with the minimum volume of air removed from the incubator. Figure 66 gives the dimensions of the most satisfactory tube that has been tested. Possibly improvements in the design of the tube and in the construction of the wick may reduce the total volume of air needed for a determination.

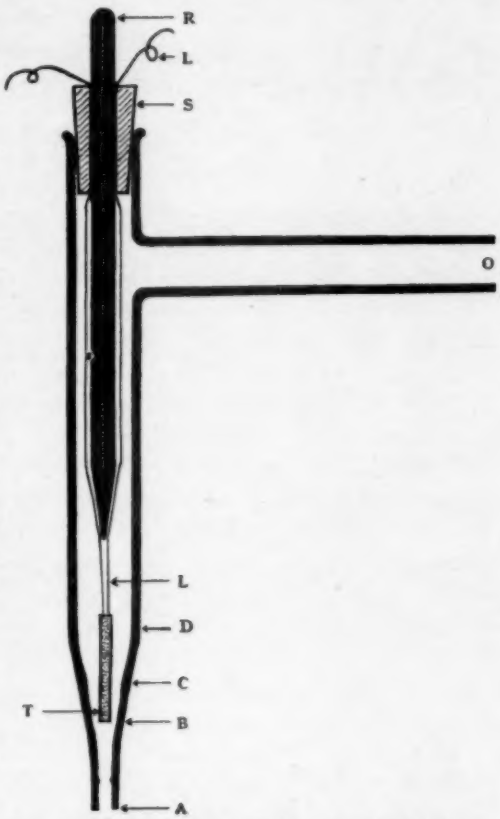

FIG. 66.—Psychrometer Tube: A. Air intake; inside diameter 7/64″; B. Inside diameter 9/64″; C. Inside diameter 17/64″; D. Inside diameter 26/64″; L. Lead wires to thermal junction; O. Air outlet; R. Rod bearing lead wires to thermal junction; S. Stopper; T. Thermal junction within wick and Distance A to D = 1 17/64″.

To use the method it is necessary to test the apparatus by comparing it with a sling psychrometer in the blast of air from a fan of high velocity. It is advisable to test the wick to be used in the psychrometer tube before testing it in the tube. If the temperature of the wet thermal junction fails to be reduced to that of the wet-bulb thermometer, adjustments must be made until this result is obtained. The apparatus cannot be considered as working satisfactorily unless the results agree exactly with the sling psychrometer. Slight deviations from this result are multiplied when the apparatus is used at other relative humidities, particularly at lower humidities. Consequently, it is desirable to test the apparatus at as low a relative humidity as possible where any discrepancies present will be more noticeable. The chief difficulties encountered are the construction of the wick, its proper placing in the psychrometer tube and the size and shape of the tube.

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THE EFFECT OF COLONY SIZE ON THE FLIGHT RATES OF HONEYBEES DURING THE PERIOD OF FRUIT BLOOM

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In previously reported work (1932) on the subject of the comparative value of different colonies of bees for use in pollination, certain variations in the activities of the colonies studied suggested that individual colonies may vary in the numbers of bees they send to the field due to factors which are independent of colony strength. Accordingly supplementary experiments were conducted during the pollination seasons of 1932 and 1933, in the hope of obtaining further information.

Since no more suitable and accurate method of measuring the number of bees flying from the colonies was available, the method used was the same as that described in an earlier paper. The out-going bees were trapped during one-minute periods at hourly intervals and then counted. Enough traps were provided so that the bees leaving all of the colonies under observation were trapped at approximately the same time. The records for 1932 were taken from twelve overwintered colonies, some of which were variously modified or manipulated and those of 1933 from eight overwintered colonies and one package of bees. The sizes and the flight averages are given in Table 1.

The counts were made in the apiary of the New York State College of Agriculture which is located about one-half mile from the College orchards. The records were taken from May 19 to May 29, 1932, and from May 14 to May 22, 1933, apple trees being in bloom during these periods. The colonies were left on their permanent locations in the apiary. Some variations existed in the conditions to which the different colonies were exposed but to have had identical light and wind conditions it would have been necessary to move the bees to a new location. This would have brought into consideration matters such as drifting and the return of the bees to their old locations.

[1]The author is indebted to Professor E. F. Phillips for suggestions in the planning of these studies and in the preparation of this paper. Thanks also are due to Professor G. H. Rea and to D. O. Wolfenbarger for assistance in conducting the experiments.

TABLE 1. SUMMARY OF FLIGHTS OF ALL COLONIES 1931–1933

Type of colony	Weight of bees, pounds	Average flight per minute	Weight of bees as % of that of average of colonies	Average flights as % of that of average of all colonies	Average flight for low temps. (42°–64°F.)	Average flight for high temps. (64°–86°F.)
1931						
Overwintered	3.00	28.53	67.02	74.32	16.95	41.19
Package bees on comb foundation	3.00	22.29	67.02	58.06	13.91	30.79
Package bees in package	3.00	20.21	67.02	52.64	11.18	29.65
Overwintered	5.00	31.41	111.71	81.82	19.72	44.39
Package bees on comb foundation	5.00	27.84	111.71	72.52	17.29	92.25
Package bees in package	5.00	40.59	111.71	105.73	29.89	51.99
Overwintered	1.63	11.77	36.42	36.66	4.81	19.17
Overwintered	4.38	56.23	97.86	146.47	37.97	76.55
Overwintered	6.50	63.00	145.22	164.11	39.42	86.57
Overwintered	8.25	84.79	184.32	220.86	59.88	112.11
Average	4.48	38.39				
1932					(38°–64°F.)	(64°–88°F.)
Overwintered	2.69	20.85	38.63	36.08	7.44	30.95
Packed overwintered	3.13	39.66	44.91	68.62	26.23	49.57
Packed overwintered	4.25	56.63	61.07	98.00	35.43	72.60
Overwintered	4.38	48.88	62.87	84.58	35.15	58.85
Modified overwintered	4.94	15.97	70.96	27.63	5.34	23.81
Overwintered	5.44	60.95	78.14	105.47	32.34	80.98
Overwintered	5.88	44.29	84.42	76.64	19.45	63.16
Overwintered	6.06	56.76	87.12	98.21	28.74	78.20
Overwintered	8.06	53.37	115.86	92.35	24.98	74.07
Modified overwintered	11.75	81.87	168.85	141.68	34.53	116.10
Modified overwintered	12.00	96.60	172.44	167.16	30.70	144.45
Modified overwintered	14.94	117.72	214.66	203.69	46.20	170.28
Average	6.96	57.79				
1933					(46°–64°F.)	(64°–82°F.)
Overwintered	2.44	37.42	44.89	58.57	27.89	46.02
Package bees on combs	3.00	24.29	55.24	38.02	20.10	27.68
Overwintered	3.63	46.60	66.75	72.93	32.48	60.47
Overwintered	4.94	64.04	90.92	100.23	40.23	87.05
Overwintered	5.38	68.68	98.97	107.49	55.07	81.15
Overwintered	5.44	64.83	100.13	101.46	40.12	88.30
Modified overwintered	7.25	85.44	133.49	133.72	43.54	128.89
Overwintered	8.31	80.01	153.07	125.22	58.02	104.08
Overwintered	8.50	105.42	156.51	165.00	78.25	133.09
Average	5.43	63.89				

A summary of the results obtained in 1932 and 1933 is given in Table 1 and the major results of 1931 are included for purposes of comparison. In addition to the average flights per minute for each colony, the weight of bees of each colony and the average flight of each colony are given as percentages of the average of all colonies for each year. The average flight per pound of bees in 1931 was 8.577 bees per minute, in 1932 it was 8.304 bees per minute, and in 1933 it was 11.765 bees per minute. The mean temperature of all observations in 1931 was 64.66° F., in 1932 it was 64.75° F., and in 1933 it was 64.04° F.

The conditions for the use of the method of determining the flight rates of the colonies used in this work were not as favorable in 1932 as in 1931 and 1933. This was no doubt due partly to the fact that the location was too heavily stocked with bees for the supply of nectar and pollen under existing weather conditions. As a result the bees were not working well during the greater part of the time that the experiment was under way. This is indicated by the fact that robbing took place frequently, and that many of the colonies were extremely excitable and the guard bees active. Many of the supposedly out-going field bees caught in the traps returned to the hives when released from the cages instead of going to the field. The dry condition of the soil in the apiary in 1932 made it practically impossible to walk past the colonies without noticeably disturbing them. During a considerable part of the time, particularly when temperatures were low, short flights were made to a nearby stream for the gathering of water. On many of these occasions no bees were flying to the field.

This method of measurement is less indicative of the true flight rates of the colonies if conditions are not such that the bees are actively engaged in the gathering of nectar and pollen. Under conditions similar to those encountered in 1932, the flight rates obtained by this method cannot be considered as accurate since the colonies are not normal. The periodic disturbance of trapping the bees keeps the colonies in a disturbed condition from which they are slow to recover.

In spite of the unfavorable conditions in 1932, some tendencies are indicated in the results. The superiority of the stronger colonies is apparent, judging by the larger number of bees caught. In 1932 the three largest colonies were obtained by uniting two smaller colonies earlier in the season. This was also done in the case of the colony containing 4.94 pounds of bees. Whether this manipulation affected the subsequent behavior of these colonies is difficult to determine, but in the case of the smaller colony thus treated there is some indication that this may have had some influence. The queen of this colony was removed April 21

and it remained queenless until May 3 when another colony was united to it. At the end of the period of observations it was discovered that the queen of this colony had been lost, there being only brood of advanced stages in the colony.

The 3.13 pound colony and the 4.35 pound colony were insulated before observations began to find the effect of packing on flight rates. These colonies were packed in a black tar paper case, there being approximately four inches of packing on the bottom, six inches on the sides and eight inches on the top. There is some indication that this treatment may have increased the flights of these colonies, as these two colonies exceeded all of the others in the number of bees sent out in proportion to the weight of bees which they contained. The entrances of these colonies, however, were exposed to sunshine in the early morning somewhat more than some of the other colonies. During this season there was little difference between the number of bees sent out by the strong and by the weaker colonies at the lower range of the temperature scale. In some cases the average number of bees sent out by the weaker colonies actually exceeded that of the stronger colonies. The large numbers of guard bees caught in the traps this season partially accounts for this, the guards at weak colonies being more active and excitable than at strong colonies. In the higher temperature ranges the superiority of the stronger colonies is obvious.

In 1933 conditions for measuring the flight rates by the method used were better than in 1932. Although many of the trees in the College orchards failed to blossom, more dandelion was worked by the bees. Except for the first and last days of the observation period and such times as weather conditions were unfavorable, flights from the colonies were apparently almost normal. At one time during the first day of the observations some attempts to rob were noticed. The last day of the observations it was noticeable that flight activity in the apiary had decreased considerably, although conditions for flight were apparently favorable. At this time most of the apple trees in the College orchards were in the last stages of bloom. It is believed that the conditions for bee activity in the orchards and on other flowers were less favorable than in 1931, although little gain in the amounts of honey in the colonies was noted either year.

In 1933 the superiority of the stronger colonies is apparent, although they failed to exceed the smaller colonies by as large a margin as might have been expected. It is to be noted that the 3.00 pound colony of package bees on drawn combs was much less efficient than the 2.44 pound overwintered colony. The counts for the package colony are

probably too high, as it was easily disturbed and a number of guards were caught in the trap. The deficiency of this colony was marked throughout the temperature range.

The 3.63 pound colony was exposed to sunshine in the early morning more than any of the other colonies. The 5.44 pound colony was the least exposed to the morning sun, being shaded by a bush. The 8.31 pound colony and the 8.50 pound colony were shaded until about 7.30 a. m. and the 3.00 pound package bees and the 4.94 pound colony were shaded until about 8:15 by an apiary building. High trees cast a light shadow on most of the colonies after about 4:00 p. m. The 2.44 pound colony was shaded lightly for short periods at various times through the day by various objects. The 7.25 pound colony was peculiar in that it was noticeable that few bees flew from it until about 9:00 a. m. This colony was formed by uniting another to it April 12, but this fact could scarcely account for such behavior. It was exposed to the sun the greater part of the day, being only partly shaded at 6:00 a. m. The rush of bees from this colony after 9:00 a. m. was exceedingly pronounced and the subsequent flight was relatively constant from hour to hour during the day. This colony seemed to be the least excitable of any of the colonies under observation.

There is no observed explanation for the differences in efficiency of the 8.31 pound and the 8.50 pound colonies. This might be attributed to differences in colony morale or to difference in the relative proportions of bees of different ages. Differences are also noticeable in the numbers of bees sent out by some of the other colonies that do not seem to be highly correlated with colony size. When individual colonies are under slightly varying external conditions, certain variations are to be expected but these hardly account for the variations in efficiency encountered. A more plausible explanation lies in the differences in morale or differences in the relative proportions of bees of different ages in the colonies. It is commonly observed that colonies of nearly equal weights often produce different quantities of honey depending upon the activities of the colony.

The consistent superiority of the larger colonies studied in the three years' work strengthens the conclusion that the use of weak colonies for pollination work cannot be justified when strong colonies may be obtained through proper beekeeping methods. It appears that manipulations which are aimed to modify colony size disturb the normal proportions of bees of different ages and has a detrimental effect on flight rates. Manipulations involving reduction of colony size particularly are to be discouraged. Weak colonies are unreliable and their use as sometimes

recommended is apt to destroy the confidence of fruit growers in bees as insurance of pollination.

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STUDIES IN THE NUMBER OF OVARIOLES IN QUEEN HONEYBEES IN RELATION TO BODY SIZE

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The production of a colony of bees depends, to a great extent, upon its numerical strength and this condition requires a high egg-laying rate by the queen for several weeks or months at a time. The factors which govern the ability of a queen bee to lay a large number of eggs are not well understood but in the absence of information to the contrary, it may be assumed to depend upon the physiological condition of the queen, the size of her ovaries, her mating, and certain inherited characteristics.

Whether a large queen is capable of laying more eggs than a smaller one is still to be determined although such is assumed to be the case by beekeepers in general. It is also not known whether a queen with a large number of ovarioles can lay more eggs than one with a smaller number, and it is difficult to determine accurately the length and breadth of a queen's ovaries and to correlate them with her egg-laying ability. Undoubtedly, the rate of metabolism of a queen plays a very important role in her egg-laying rate and it would be of value to the beekeeper to have some external factor by which to judge this potential value.

The purpose of this paper is to present the results of studies to determine the relation between the size of ovaries, as indicated by the number of ovarioles, in queen bees and their body size.

METHODS.—Due to the fact that the honeybee in the United States is the result of the importations of different strains from European countries, it is very difficult, if not impossible, for us to secure definite line-bred strains of Italian bees in this country. A select-tested queen was therefore secured from one of our foremost queen breeders for use in these studies. This queen, No. 61, produced workers, drones, and queens that were evenly marked, thus indicating pure mating for two or more generations. Different lots of queens were reared from

her as well as from her daughters and the average size and number of ovarioles of each lot was determined. Body measurements and ovariole counts were taken also of queens reared from other so-called strains of Italians for comparison. All queens were reared according to recognized commercial methods of queen rearing and the conditions of environment were made as similar as possible. An attempt was also made to check the influence of age of larva at time of grafting on the number of ovarioles and size of queen. More than two hundred and eighty queens were examined in these studies.

METHODS OF COUNTING THE NUMBER OF OVARIOLES.—In counting the number of ovarioles in the ovaries of queens, two methods were tried. In one, the ovaries were sectioned and the sections projected on a

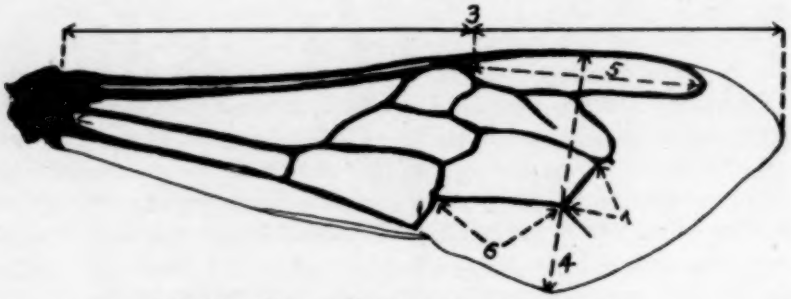

FIG. 67.—Diagram showing wing measurements.

wall chart by means of a Leitz projector. This method was found to be slow and did not give uniform counts for serial sections taken from any one ovary. The second method consisted of making a direct count of the ovarioles under a dissecting microscope. In this method, the right and left ovaries were placed in separate vials of Bouin's solution and allowed to remain for approximately ten minutes, after which time the ovarioles had hardened sufficiently to permit separation without tearing or breaking. To facilitate the count, the top third of each ovary was cut off and the ovary divided longitudinally into ten to fifteen parts as the count progressed. This method gave accurate results and the counts secured were higher than those made by the projection method. Laying queens were used in both methods.

Since the weight or total length of an emerged queen was found to vary with her activity and with environmental influences, the size of a queen was determined by taking various body measurements. The following measurements were taken by the use of the projector during which a magnification of 100 times was used:

TABLE 1. FREQUENCY DISTRIBUTION OF THE OVARIOLES OF QUEENS REARED FROM DIFFERENT STRAINS OF THE ITALIAN HONYBEEE

Class	Number of Strains														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	f
260–265							1								1
266–271															
272–277							4								4
278–283							2								2
284–289						1	3								4
290–295					1	1	6	2					1		11
296–301			2		1	2	1	5			1				12
302–307			2		2		4	7	1						16
308–313		1			4	3	1	14		1	1	2	1	2	30
314–319	2		2		2	2	3	7			2	1	1	3	25
320–325	2		2		1	3	2	13			3	2	4	5	37
326–331	1	2		1			4	9		3	2	3	1	6	32
332–337	2			1		3		8			2	2	2	8	28
338–343	2			1	1			6	1		2		4	11	28
344–349		2						4	2	1	1	2		11	23
350–355	1							2	2		1		2	4	12
356–361				1					1	1	1		1	2	7
362–367				1							1	1	1	2	6
368–373								1						1	2
N	10	5	8	5	12	15	31	78	7	6	17	13	18	55	280
Average No. ovarioles	331.0	332.8	309.7	345.6	311.0	314.1	298.7	321.7	343.3	333.0	332.1	330.7	333.1	338.5	

Mean, 325.3 ± 0.79; standard deviation, 19.8 ± 0.564; coefficient of variability, 6.08 ± 0.173.
Mean number of ovarioles in left ovaries, 162.8 ± 0.432; standard deviation, 10.73 ± 0.337; coefficient of variability, 6.59 ±0.207.
Mean number of ovarioles in right ovaries, 163.5 ± 0.371; standard deviation, 9.180 ± 0.288; coefficient of variability, 5.61 ± 0.176.

1. The extreme width of the head.
2. The length of the head as indicated by the distance from the vertex to a horizontal line drawn between the outer edges of the articulations of the mandibles.
3–7. Wing measurements as shown in Fig. 67.
8. The length of the femur.
9. The length of the tibia.
10. The length of the first tarsal joint.

THE NUMBER OF OVARIOLES IN QUEEN HONEYBEES.—According to Koshevinkov, as reported by Alpatov,[1] rudiments of the future ovaries in the honeybee are present in the newly hatched larva. During its larval life the number of egg tubules increases and at the moment of transformation of a larva into a pupa, the larval ovary contains approximately 200 embryonic egg tubes. At the beginning of histolysis the ovary of the worker larva ceases to increase in size, unlike the ovary of the queen, which grows more and more. Only one to twelve tubes develop in the worker larva while in the queen larva, all the egg tubes develop perfectly and give rise to the enormous ovary of the mature queen. The factor, of course, which causes the difference between this development in the worker and queen is the nourishment each receives during its larval period.

In light of the above facts, any difference in the number of egg tubules in queens reared under similar environmental conditions would be due, most likely, to inheritance. Table 1 shows such a tendency, although a wide range is demonstrated in the number of ovarioles between different specimens within any given strain. It is also shown that an extreme variation of over 100 ovarioles may exist between individual queens. The variation from the mean, however, was only a —27 and a +20. There was a difference of only 0.7 in the number of ovarioles between the left and right ovaries, in favor of the right.

When queens were reared from larvae, that varied from 12 to 72 hours of age at the time of grafting, and produced from queen No. 61, no correlation was indicated between the number of ovarioles in the mature queens and the age of larva, as is shown by Table 2. In this experiment the bees would accept no larva that was older than 72 hours, although repeated attempts were made to get them to do so. Zander

[1]ALPATOV, W. W. The Influence of the Conditions of Development on the Organism of the Worker Bee and the Queen. A. B. J., Vol. LXVIII, No. 3, p. 115–117, 1928.

and Becker[2] report success in getting bees to accept larvae up to 3½ days from the egg stage and produced from those over 3 days of age forms that were intermediate between the queen and worker bee. They also produced intermediate creatures by reducing the amount of food in queen cells during the developmental period. Out of 281 queens examined during the past season, only one intermediate form was found and that was produced by a nucleus. This queen had only 231 ovarioles and was no larger than a worker bee in size.

TABLE 2. FREQUENCY DISTRIBUTION OF NUMBER OF OVARIOLES IN QUEENS REARED FROM BREEDER NO. 61 IN WHICH LARVAE OF DIFFERENT AGES WERE USED AT TIME OF GRAFTING

Total Number of Ovarioles	Ages of Larvae at Time of Grafting in hours						
	12	24	36	48	60	72	f
290–295	1				1		2
296		1	2				3
302	1	2			1	1	5
308	2	2	3	1	2	1	11
314	1	2	1		2		6
320		3	2		3	1	9
326		2	1		2		5
332	4						4
338		1				1	2
344	1						1
350							
356							
362							
368					1		
Number	10	13	9	1*	12	4	49
Average	322.2	317.6	313.2	312	319.4	320.5	

Mean = 318.8 ± 1.21
Standard deviation = 12.5 ± 0.96
Coefficient of variability = 3.93 ± 0.30
Breeder No. 61 had 335 ovarioles

*Practically all the ovaries of this class were embedded and sectioned. As the counts of sectioned material were invariably lower than direct counts and since duplicate counts of serial sections could not be made, these data were not included with those taken by direct methods.

THE SIZE OF QUEENS.—Alpatov[3] reports that the size of the worker bee depends upon such environmental conditions as age of nurse bees, size of cell, and the differing environmental conditions of the seasons. Nutrition, temperature, and the size of cell have the greatest influence upon the size of bee produced. Body proportions remain much the same between small and large bees of the same strain while there is a relatively smaller difference between the body appendages; i. e., small bees have relatively longer tongues and legs than large bees. Similar

[2]ZANDER, ENOCH, and BECKER, FRANZ. Die Ansbildung des Geschlechtes bie der Honigbiene II. Erlanger Jahrbuch für Bienenkunde, Vol. 3, p. 161–223. 1925.

[3]ALPATOV, W. W. Biometrical Studies on Variation and Races of the Honeybee (*Apis mellifera* L.). The Quar. Review of Biology, Vol. IV, No. 1, p. 1–58, 1929.

correlation may be assumed to exist between body measurements and appendages in the case of queen bees.

In the present studies no definite correlation was found to exist between the size of 83 queens and their number of ovarioles, as indicated in Tables 3 and 4. This might be expected from the fact that the ovarioles of the queen originate in the larval stage before the factors of nutrition, temperature, and size of cell have had time to be effective. It is evident, therefore, that the size of the queen cannot be used as an index to the number of ovarioles a queen may have. Although it remains to be demonstrated whether a queen with a large number of ovarioles can lay a correspondingly larger number of eggs than one with a smaller number, it seems evident from the data here presented that measurements other than the number of ovarioles should be considered as indices of potential egg-production.

TABLE 3. BIOMETRICAL CONSTANTS OF 28 QUEENS REARED FROM BREEDER NO. 61, FROM SAME AGE OF LARVAE

Measurements Taken	Mean, in mm	Standard deviation	Coefficient of variability	Correlation with Number of Ovarioles
Right fore wing.....				
Length.....	9.605±0.025	0.202±0.049	2.10 ±0.188	+0.085±0.126
Width.....	3.055±0.012	0.092±0.008	3.01 ±0.276	—0.048±0.013
Length of leg joints				
Tibia.....	3.451±0.012	0.117±0.010	3.39 ±0.305	+0.015±0.127
1st tarsal.....	2.391±0.016	0.129±0.011	5.41 ±0.487	—0.059±0.127
Head measurements				
Length.....	3.228±0.011	0.088±0.007	2.726±0.245	—0.060±0.126
Width.....	3.817±0.01	0.081±0.007	2.12 ±0.19	—0.008±0.123
Mean No. of ovarioles in the 28 queens...	327.5±1.91	15.05±1.35	4.59 ±0.41	

TABLE 4. BIOMETRICAL CONSTANTS OF 55 QUEENS REARED FROM A DAUGHTER OF BREEDER NO. 61, THE SAME AGE OF LARVA BEING USED AND QUEENS REARED UNDER FAVORABLE CONDITIONS

Measurements Taken	Mean, in mm	Standard deviation	Coefficient of variability	Correlation with Number of Ovarioles
Right fore wing				
Length.....	9.691±0.026	0.2815±0.018	2.90±0.188	+0.085±0.126
Width.....	3.187±0.013	0.147±0.009	1.39±0.09	—0.089±0.091
Length of leg joints				
Tibia.....	3.692±0.001	0.159 ±0.01	4.30±0.276	+0.011±0.091
1st tarsal.....	2.437±0.013	0.153 ±0.009	6.28±0.404	—0.053±0.091
Head measurements				
Length.....	3.303±0.009	0.104 ±0.006	3.14±0.201	—0.007±0.091
Width.....	3.883±0.008	0.094 ±0.006	2.42±0.155	—0.024±0.091
Mean No. of ovarioles in the 55 queens...	338.56±1.20	13.24±0.852	3.90±0.25	

In the case of the queens reared from larvae of different ages at time of grafting, queens produced from 60 and 72 hour larvae were progressively smaller in size than those produced from younger larvae. These results agree with the evidence of Zander and Becker. Although there was but little external or internal difference other than size between queens reared from three-day-old larvae and those reared from younger larvae, three queens reared from the former were superseded within two months of the time they were introduced into normal colonies, thus indicating inferiority of these queens.

ADULT BEES FOUND DYING ON SPOTTED LOCO

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For several years a condition involving the death of adult bees has appeared in Nevada, particularly in the Mason Valley area of Lyon County. The brood is affected, primarily if not wholly, by neglect resulting from the diminution in colony population. Only in certain seasons has the trouble become serious. Popularly called a new disease or the Nevada disease, it has led to restrictive measures regarding the moving of colonies. This latter problem makes advisable an announcement that adult bees were found dying upon a plant in this area.

Astragalus lentiginosus,[1] spotted loco, is the plant upon the blossoms of which bees were found dying (May 23 to June 2, 1933). The death rate was not excessive; nor did the plants appear numerous, except in two small areas. Abundance of the species varies extremely from season to season, depending upon rainfall and climate, as the observations of three consecutive years have shown. Occasionally, severe winter temperatures kill almost all the old plants except on the southwest exposures; and when local rainfall is insufficient the germination of the large seed is delayed indefinitely. Recorded variability in prevalence of the poisoning is apparently in direct proportion to the abundance of the *Astragalus* blossoms and the simultaneous absence of more attractive wholesome nectar and pollen. Conversely, furthermore, when the first alfalfa crop is cut, bees must suddenly seek other nectar-producing plants. In years when sweet clover is scarce, the desert flora is almost the only source of nectar until the second alfalfa crop begins to blossom.

[1]The identification was made by G. H. Vansell and later verified by Dr. S. F. Blake of the Bureau of Plant Industry from a specimen submitted to that Bureau.

Very likely, additional species in the local desert flora might also be detrimental; other species of *Astragalus* are known to be present.

The trouble is reported to cease abruptly at times, occasionally recurring later in the same season. A possible explanation was discovered

FIG. 68—Spotted loco (*A. lentiginosus*). The plant is easily pulled out because the slender root stalk is brittle.

on May 26, 1933, when a hot north wind blasted the blossoms of spotted loco. Within four days, however, as the weather moderated, blossoms again became plentiful on the same plants.

Bees at times visit *Astragalus* plants freely for both nectar and red pollen. Not all the visitors are visibly affected while working on the plants, but many drop along the way back to the hive and even after arrival. At one time in 1931, in fact, numerous bees carrying nectar reached the hives so weakened that they were unable to enter and soon expired. The cause of their death was not the heat of the sand, for the entrances were, at the time, shaded by the hives, but some poison, acting so slowly as to permit arrival at the colony.

Affected colonies, upon removal into either the Sweetwater mountains of Nevada at an elevation of 6,000 feet or the Sacramento Valley of California, at 67 feet elevation, immediately became normal and remained so. The altitude of the Mason Valley is about 4,300 feet.

In the area where this trouble has occurred, some of the disheartened beekeepers, unable to understand the cause of their difficulties, have allowed their apiaries to deteriorate abnormally. Any adverse condition, apparently, they blamed upon "the disease," not realizing that other factors, including an occasional severe winter, contributed. With the present knowledge as to definite causes of difficulty, these local beekeepers should take heart, for undoubtedly general conditions can be markedly improved.

Plants of *Astragalus lentiginosus,* especially when bearing the shiny white seed pods, are very conspicuous among the dwarf desert flora. They average about one foot in height. The blossoms are creamy white, an occasional one showing a purplish tinge at the tips of the petals. The seed pods are large—about half an inch long—and bladdery. The figure shows this species of plant with its blossoms and seed pods.

AN ATTEMPT TO STUDY THE EFFECTS OF RELATIVE HUMIDITY ON HONEYBEES

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Since it would appear from casual observations on honeybees that relative humidity plays a major rôle in length of life and in various phases of their activities, a series of experiments were undertaken in the winter of 1932–33 to determine more accurately the effects of this environmental factor. The chief difficulty in work of this nature is to control relative humidity with accuracy while other environmental factors remain constant. The observations made in this work fail to give results which are wholly satisfactory, but it seems well to record the methods used and the results obtained, as a guide to others who may undertake work of a similar character on honeybees or other insects. With honeybees it is obviously essential that they constantly have available a readily accessible food supply and it is desirable that the oxygen supply shall at no time be reduced. This appears to make it essential that air circulation be maintained if small chambers are used to confine the bees, and this obviously complicates any attempt to control relative humidity.

METHODS—Large (150x190 mm.) desiccators were used as humidity chambers in which the bees were placed. A vacuum pump was used first to draw the air through the various conditioning solutions, and then through the humidity chambers. The relative humidity in each chamber was tested by placing in it a small hair hygrometer which was constantly checked against wet and dry bulb thermometers. It was further tested by inserting a dew-point apparatus in the system between the humidity chamber and the vacuum pump. The apparatus was operated for several days with no bees in the chambers, during which time its efficiency was continually tested by the two methods and the several chambers were found to maintain the anticipated relative humidities.

Different strengths[1] of sulphuric acid were used to condition the air as to relative humidity, the relative humidities which it was undertaken to obtain by the use of acid solutions being 0%, 14%, 28%, 50%, 70%, and 84%. For the three lowest relative humidities, the air was first passed over lumps of calcium oxide and strong acid to dry the air, then through the appropriate strengths of acid to give the desired relative humidities. Since the relative humidity of the air in the room in which the

[1]Wilson, Robert E. Humidity control by means of sulphuric acid solutions with critical compilation of vapor pressure data. Jr. Ind. & Eng. Chem. 13: 326–331. 1921.

experiments were being conducted was usually slightly above 50%, the preliminary conditioning of the air was unnecessary for the higher relative humidities. Before entering the humidity chambers, the air was passed through the appropriate acid solution in a liter flask and then through a gas washing bottle containing the same strength of acid. The acid solutions were made up and tested by means of hydrometers. The same strength of acid solution used in conditioning the air for each humidity chamber was also placed in the bottom of each chamber as a further aid in maintaining the desired relative humidity.

A 99% chamber was maintained by drawing air through vessels of water which were warmed to about 150° F. This air passed through several feet of tubing and over a trap to cool it to room temperature before it entered the humidity chamber.

Screw clamps which were used to insure an equitable flow of air through the several humidity chambers were set to allow the passage of about ten liters of air per hour. The partial pressure used to pass air through these humidity chambers was found, by the use of an attached mercury manometer, to have reduced the pressure about 10 to 15 mm.

The bees were confined in wood and wire cloth cages (about 1 x 4 x 6 inches) within each humidity chamber. Food was provided in the form of a 50% sucrose solution in muslin-covered vials which were inverted over the cages. The bees were not counted when placed in the cages, to avoid any undue excitement. Each cage was removed from its humidity chamber daily in order to remove any bees which had died during the interval since the last checking, but they remained outside the humidity chamber not more than ten minutes at any time. The total of all bees removed gave the total used in each experiment.

This experiment was carried on in a dark room, except for light which was used at the time the daily records were taken, where the temperature averaged 82° F. and ranged from 78° to 87° F.

Discussion of Results.—In the following discussions and in the table, the humidity chambers are designated by the percentages of relative humidity in them prior to the introduction of the bees. The "14% humidity chamber," for example, is thus indicated, although after the bees were introduced, its relative humidity rose to considerably higher figures.

After the apparatus had been running several days, during which time tests showed it to be working accurately, the bees were put in the cages in the several humidity chambers. Unfortunately only one hair hygrometer was available for use through the experiment; the use of one other was obtained for a short time. One was put in the 14% humidity

chamber with the bees. Inside of half an hour after the bees were introduced, the hygrometer indicated 70% relative humidity. This hygrometer, which was checked daily against wet and dry bulb thermometers, was kept in the 14% humidity chamber throughout the experiment. Its reading the next day after the bees were put in was 68%; the average daily reading for the experimental period was 62.5%. The 0 humidity chamber was tested by placing a hair hygrometer in it with the bees for a period of nine days. Its readings over a nine-day period averaged 47.75%. The 50% chamber gave dew-point readings of 70 and 80 per cents. The 84% chamber tested 90% or above. The 50% and 84% cages were discontinued after it was found that the air flow had accidentally become stopped so that the bees were affected and many had died. It was difficult to determine when the 99% chamber tested 98%, or 100%.

In Table 1 is shown the number of bees in each chamber, the average length of life in days, the amount of food taken per bee per day, measured in milligrams, and the relative humidity of the chambers, without bees, after the experiment was concluded.

TABLE 1. APPARENT EFFECTS OF DIFFERENT RELATIVE HUMIDITIES ON THE AMOUNTS OF FOOD CONSUMED AND THE LENGTH OF LIFE OF HONEYBEES

Relative humidity sought	Number of bees in cage	Average length of life of bees in chamber, in days	Average amount of food solution consumed per bee per day in mg.	Relative humidity in chambers at end of experiment
0%	282	*36.9 ± 2.1**	26.9 ± 1.4	0%
14	359	*26.9 ± 1.0	29.3 ± 2.1	21
28	283	*30.0 ± 1.3	34.5 ± 2.5	30
70	257	19.6 ± 1.5	28.3 ± 2.0	69
99	251	12.9 ± 1.5	57.3 ± 7.3	100

*In this calculation it was assumed that the bees mentioned in the text as being alive at the end of the experiment had died on the 40th day.
**Standard error.

The experiment was discontinued at the end of 40 days. One hundred ninety-nine (70.56%) bees were alive at that time in the 0% humidity chamber, five were alive in the 14% chamber, and 23 were alive in the 28% chamber. The bees in the 70% and 99% chambers were all dead, however, after 25 days. Since some bees were yet alive, comparisons of the average length of life per bee are not truly accurate.

In every case, except in the 99% humidity chamber, the relative humidity was considerably increased by the bees. Bees took up the sugar solution which on utilization gave off aqueous vapor with a consequent rise of relative humidity. The flow (5 to 15 liters per hour) of

conditioned air was apparently insufficient to carry off the additional water vapor due to utilization of food.

In spite of the apparent difficulties of maintaining these bees in controlled humidity chambers the following points may be seen: (1) bees build up relative humidity, (2) the bees die more rapidly, and apparently take more food at or near the saturation point, and (3) this closed system of relative humidity control as here given was not successful, with the comparatively large numbers of bees used, in maintaining relative humidity at the desired percentages.

PRELIMINARY STUDIES IN THE PHYSICAL CHARACTERISTICS OF SOME MASSACHUSETTS HONEYBEES

By CLAUDE R. KELLOGG and DEAN ASQUITH

Although the honeybee has been associated with man since the dawn of history very little progress has been made in its domestication and improvement, due, of course, to the difficulties encountered in attempting to control the mating. Now, however, with the development by Dr. Watson of a successful, if delicate, method of artificial insemination of queen bees, we may consider the study of Genetics as applied to the honeybee as well begun and there is no reason why the bee should not yield to efforts at improvement as have the other animals associated with man.

Before much can be accomplished in this direction, however, it seems clear that a careful analysis must first be made of the inheritable characteristics of the bee, the desirable ones found and isolated, and then, after this is accomplished, will come the application of the methods of Genetics in the improvement of the honeybee.

The studies reported in this paper were undertaken in an effort to determine if some of the individual colonies of bees in the apiary of the Massachusetts State College did not show sufficient variation in certain characters to encourage further work looking toward their isolation. If such useful variations could thus be found and isolated, the next step would be their fixation into strains through hybridization and further selection. Environmental factors must be rigidly controlled for the work of Baudoux in Belgium and Pincot in France show the effect of cell size upon the size of the bees reared in them, and Alpatov (1929) has established the fact that changes in physical characters may be due to the influence of season, age, variation in food supply, temperatures, etc.

Probably the first student of the physical characteristics of bees, at least from a practical standpoint, was Wankler, a worker in Germany who, as early as 1822 had perfected an instrument for measuring tongue length. Charton, working in France, invented a glossometer in 1892 and in 1897 had presented some data which seemed to indicate, though erroneously, that bees store honey in proportion to the length of their probosces.

Mr. A. I. Root was the first to arouse an interest in this subject in America and for a number of years was a strong champion of the selection of bees for tongue length. Merrill (1922) studied the subject scientifically and showed that there was no close relation between the tongue length and honey production in a colony. He did find, however, a high correlation between carrying capacity, colony strength, tongue length, and yield of honey, showing that all three of the above characteristics should be present, or, at least two of them to a marked degree, in order to have good yields of honey. Hutson showed later that there was no marked relationship between the length of tongue and yield of honey but that there did exist a high correlation between colony strength and honey production. Doubtless many factors enter into honey production and the improvement of the bee will depend, not upon any one factor alone, but upon the analysis and selection of many.

In the present study several physical characteristics were examined to see how great a variation they might show and the results so far gained seem sufficient encouragement to carry the work on through the coming season.

Size of Wings.—Tables 1, 2, and 3 give the results of measurements made through a binocular with the aid of an ocular micrometer upon individual wings of worker bees. A variation of .7329 mm. was found between the shortest and longest wings, the longest one showing an increase of 8.2% over the shortest one. Alpatov (1929) showed a seasonal variation of 4.5% between wing lengths of colony averages but in the colony averages of the present study, a much greater variation than that is apparent. The area, or surface, of the wings, found by taking one-half the product of the length times the width (on the assumption that the wing is nearly triangular in shape) shows a difference between colony averages of .999 square millimeters, or 6.8%. Tables 4, 5, and 6 are the work of the junior author and the data for them were secured in a slightly different manner from the above figures. The wings were projected, by means of a small stereopticon, upon a white wall in a dark room, and the measurements taken by a calibrated ruler. The two sets of wings, because of the different methods of study, should

TABLE 1. LENGTH OF WINGS

(Right fore wings measured in mm.)

Values (mm.)	Frequencies								Totals
	Hive No. 1	Hive No. 4	Hive No. 9	Hive No. 13	Hive No. 16	Hive No. 19	Hive No. 35	Hive No. 36	
9.6324	7		1	1					9
9.5277	19	1	12	3	1	1		5	42
9.4230	19	6	14	5	10	11	1	8	74
9.3183	9	14	14	20	10	9	3	10	89
9.2136	1	18	4	16	11	12	7	22	91
9.1089		13		4	17	1	14	1	50
9.0042		4		0	1		9		14
8.8995				1					1
Total number of bees	55	56	45	50	50	34	34	46	370
Mean =	9.4649	9.2285	9.4044	9.2889	9.2429	9.3152	9.1304	9.3046	9.3036
	±.0092	±.0108	±.0105	±.0118	±.0123	±.0125	±.1269	±.0112	±.0008
σ =	.1010	.1210	.1041	.1239	.1291	.0999	.1069	.1126	.1473
	±.0065	±.0077	±.0074	±.0083	±.0087	±.0081	±.0087	±.0079	±.0036
C. V. =	1.07%	1.31%	1.09%	1.33%	1.39%	1.07%	1.10%	1.21%	1.58%
	±.0068	±.0835	±.0775	±.0877	±.0942	±.0874	±.1340	±.0850	±.0392

TABLE 2. WIDTH OF WINGS

(Right fore wings measured in mm.)

Values (mm.)	Frequencies								Totals
	Colony 1	Colony 4	Colony 9	Colony 13	Colony 16	Colony 19	Colony 35	Colony 36	
3.4551	2	1			1	1		2	7
3.3504	28	10	23	8	21	11	6	28	135
3.2457	24	24	20	22	14	8	12	15	139
3.1410	1	13	3	19	9	13	18	1	77
3.0363		5		1	1	0	0		7
2.9316		1				1	1		3
2.8269						1			1
Total number of bees	55	54	46	50	46	35	37	46	369
Mean =	3.3047	3.2185	3.2912	3.2185	3.2730	3.2217	3.2032	3.3162	3.2584
	±.0056	±.0095	±.0064	±.0074	±.0090	±.0148	±.0099	±.0061	±.0033
σ =	.0624	.1031	.0642	.0778	.0911	.1302	.0893	.0619	.0952
	±.0041	±.0067	±.0045	±.0052	±.0064	±.0105	±.0070	±.0043	±.0023
C. V. =	1.88%	3.20%	1.95%	2.42%	2.78%	4.04%	2.78%	1.86%	2.92%
	±.1213	±.2076	±.1371	±.0163	±.1954	±.3257	±.2181	±.0131	±.0624

TABLE 3. WING AREA OF RIGHT FORE WINGS ½ (LENGTH x WIDTH)
(Compiled from Tables 1 and 2)

Colony number	Number of bees	Length of wing (mm.)	Width of wing (mm.)	Area of wings (sq. mm.)
1	55	9.46	3.30	15.609
4	54	9.23	3.22	14.860
9	46	9.40	3.29	15.463
13	50	9.29	3.22	14.950
16	46	9.24	3.27	15.108
19	35	9.31	3.22	14.980
35	37	9.13	3.20	14.610
36	46	9.30	3.32	15.438
Number of colonies	Total number of bees	Average length of wing	Average width of wing	Average wing area
8	369	9.295 mm.	3.255 mm.	15.127 sq. mm.

TABLE 4. LENGTH OF RIGHT FORE WINGS

Colony number	Number of bees	Shortest length	Average length	Greatest length
Italians				
23	19	9.18	9.381	9.83
24	29	9.18	9.464	9.83
D-1	26	9.24	9.515	9.83
Totals and averages	74	9.20	9.453	9.83
Caucasians				
25	12	9.02	9.23	9.51
27	50	9.50	9.70	10.20
28	63	9.80	10.09	10.30
Totals and averages	125	9.44	9.53	10.003

TABLE 5. WIDTH OF RIGHT FORE WINGS

Colony number	Number of bees	Shortest width	Average width	Greatest width
Italians				
23	19	3.033	3.137	3.278
24	29	3.033	3.235	3.360
D-1	26	3.11	3.268	3.360
Totals and averages	74	3.056	3.213	3.333
Caucasians				
25	12	2.95	3.096	3.196
27	50	3.00	3.250	3.50
28	63	3.16	3.340	3.50
Totals and averages	125	3.036	3.228	3.398

TABLE 6. WING AREA OF RIGHT FORE WINGS
(Compiled from Tables 4 and 5)

Hive number	Number of bees	Smallest wing area sq. mm.	Average wing area sq. mm.	Greatest wing area sq. mm.
Italians				
23	19	13.921	14.7130	15.718
24	29	14.29	15.3080	16.52
D-1	26	14.39	15.5475	16.52
Totals and averages	74	14.20	15.189	16.25
Caucasians				
25	12	14.04	14.2880	14.80
27	50	15.00	15.9800	17.50
28	63	16.00	16.6280	17.70
Totals and averages	125	15.013	15.632	16.66

not be compared with one another, but comparisons within each group are valid. The work of the junior author shows a variation in wing area of 5.08%. Whether these differences have any practical significance remains to be proven by further studies.

TABLE 7. CAPACITY OF NECTAR SACS

Hive number	Number of bees	Smallest nectar sac (cc.)	Average nectar sac (cc.)	Largest nectar sac (cc.)
Italian				
23	19	.016	.029	.046
24	29	.013	.038	.063
D-1	25	.013	.041	.063
Caucasian				
25	12	.013	.027	.036

CAPACITY OF NECTAR SACS.—As has already been stated, Dr. Merrill (1922) found a high correlation between honey production and carrying capacity in colonies of bees. With this in mind the junior author undertook a study of four colonies to determine the average nectar capacity for each colony. The method used in the study was worked out from a suggestion by Dr. Merrill. A 40% sugar solution at room temperature was placed in shallow dishes on the inner cover of the colony where the bees could easily find it. When individual bees, apparently satisfied, turned away from the syrup to return within the hive, they were caught, their heads immediately crushed to prevent regurgitation of the solution, and then taken into the laboratory. The nectar sac of each bee was dissected out and placed in a small glass tube containing a 50% solution of alcohol. A millimeter ruler back of the glass tube was used to take the readings. If the bore of the tube is known, the cubic contents of each nectar sac can be accurately measured.

As may be seen from the table, the nectar sac with the largest load contained 4.8 times as much sugar solution as the sac containing the smallest load, and the average of the colony with the highest capacity was 1.5 times as much as that of the colony exhibiting the lowest capacity. If this variation in carrying capacity can be proven to be constant for each colony and inheritable it should make a promising characteristic upon which to base comparison and selection between colonies. While .014 cc. is a small amount of nectar in itself, that small difference in a colony of 50,000 bees would amount to a difference of 700 cc. or 23.667 ounces, or 1.43 pounds per trip.

WEIGHT OF POLLEN CARRIED BY HONEYBEES.—Table 8 gives the results of a study of 465 bees to determine the weight of individual bees and also the amount of pollen carried at one trip. To make sure of get-

TABLE 8. WEIGHT OF POLLEN CARRIED BY HONEY BEES

Dates	Colony number	Number of bees	Total weight of bees with pollen (gms.)	Total weight of bees less pollen (gms.)	Total weight of pollen only (gms.)	Weight of one bee empty (gms.)	Weight of pollen carried by one bee (gms.)	Percentage of body-weight carried in pollen
May 16.....	3	21	2.222	1.876	.346	.0894	.0164	18.4
	4	32	3.946	3.315	.631	.1035	.0197	19.03
	9	15	1.563	1.422	.141	.0948	.0094	9.5
	14	32	3.695	3.277	.418	.1024	.0131	12.75
	17	9	.953	.792	.161	.0880	.0180	20.5
	20	11	1.039	.945	.094	.0859	.0085	9.9
	D 1	27	3.060	2.460	.600	.0911	.022	24.1
Total and averages..		147		14.087	2.391	.0951	.01626	16.27
May 23.....	3	12	.979	.854	.125	.071	.010	14.0
	4	22	1.840	1.610	.230	.073	.010	13.6
	9	13	1.036	.879	.157	.067	.012	17.8
	14	17	1.497	1.205	.292	.070	.017	24.5
	17	12	.954	.825	.129	.068	.010	14.7
	16	20	1.762	1.476	.286	.073	.014	19.1
	17	12	.954	.825	.129	.068	.010	14.7
	19	21	1.750	1.450	.300	.069	.014	20.3
	20	13	1.082	.960	.122	.073	.009	12.3
	D 1	18	1.572	1.292	.280	.072	.015	21.1
Total and averages..		148		10.551	1.921	.0712	.0129	17.48
May 27.....	4	17	1.497	1.215	.282	.0715	.0165	23.21
	16	20	1.762	1.476	.286	.0738	.0143	19.37
	19	21	1.750	1.450	.300	.0690	.0143	26.19
Total and averages..		58		4.141	.868	.0713	.0148	23.19
July 14.....	4	20	2.119	1.802	.317	.0901	.01588	17.59
	19	8	.703	.605	.098	.0756	.0122	16.19
Total and averages..		28		2.407	.415	.0866	.0148	16.89
July 18.....	4	35	3.263	2.663	.600	.0761	.0171	22.53
	16	30	2.454	2.206	.248	.0735	.0083	11.24
	19	19	1.668	1.473	.195	.0775	.0103	13.17
Total and averages..		84		6.342	1.043	.0755	.0124	15.64
Grand total and averages.....		465		37.588 gms.		.08070 gms.	.0142 gms.	17.894%

ting bees of one age for comparison, pollen carriers were captured at the entrances of their hives as they returned, loaded with pollen, from the fields. The bees, anaesthetized by ether or cyanide were weighed in groups, the pollen removed, and the "empty" bees weighed again, after which they were returned to the hives to recuperate. From the figures obtained in this way it was easy to compute the average weight of single bees and the average loads of pollen carried by them.

From this study it is noted that the average weight per bee in the various colonies varied from .0172 grams to .0951 grams, with the general average of .08070 grams per bee; that the weight of pollen carried by a single bee varied from .0124 to .0163 grams, with an average for the 465 bees of .0142 grams of pollen per load; and that the percentage of body weight carried in pollen by individual bees varied from 15.64% to 23.19%, with an average of 17.89% for an individual bee.

SUMMARY.—Three hundred seventy honey bees were examined for variations in their physical characteristics with the following results:

1. The length of wing in the bees studied varied from 8.89 mm. to 9.63 mm., with an average of 9.304 mm; the width of wing in these same bees varied from 2.83 mm. to 3.45 mm., with an average of 3.258 mm.; the average area of wings per colony varied from 14.61 to 15.61 mm., with an average wing area per colony of 15.127 square millimeters.

2. The capacity of the smallest nectar sac of the eighty-five bees studied was .013 cc., the capacity of the largest nectar sac was .063 cc., while the average nectar sac per colony varied from .027 to .041 cc.

3. Four hundred and sixty-five pollen carriers were tested for weight of pollen carried and for weight of body.

The average weight of one bee, with its load of pollen removed, was .0807 gram; the average weight of pollen carried per bee was .0124 gram, and the percentage of body weight carried in pollen varied from 9.5% to 24.1%, with an average of 17.89% for the entire group.

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PLANNING AN EXTENSION PROJECT IN BEEKEEPING

By Edwin J. Anderson

In developing an extension program in beekeeping it would seem that the first efforts should be directed towards the obtaining of a knowledge of the beekeeping methods in the different sections of the State so as to obtain a more complete understanding of the beekeeper's problems. The program for a period of years can then be developed around the needs of each community in which the work is to be done.

In the western sections of the State of Pennsylvania American foulbrood is well established and causes rather heavy losses each year. Homemade hives of odd sizes are still common in this part of the State. Many of these hives are difficult to handle. Factory made equipment can not be used in many of these apiaries.

In the southcentral and eastern sections of the State fruit growers are using bees extensively for pollination purposes. Most of the growers own the bees so as to insure the proper pollination of their fruit. They do not care to bother with any honey the bees might produce. Recommendations for this type of beekeeping must necessarily vary considerably from those for beekeepers wishing to produce a maximum crop of honey.

In the eastern half of the State beekeeping is advanced. In this section the need is for information on advanced beekeeping, such as bottling, marketing, grading and variations in management for comb honey production.

The time of the honey flow and sources of the honey flows also show a great variation for the different sections of the State so that the management problems vary accordingly. In the northcentral area of Pennsylvania the surplus honey flow is largely from fall flowers, such as goldenrod and aster which come into bloom during the later part of August and September. In the lime stone valleys the surplus honey is obtained from alsike and sweet clover which bloom during June and July. In this section of the State there is seldom a fall honey flow to prepare the bees for winter.

Over the State as a whole comb honey has been produced extensively while the production of extracted honey has been neglected to such an extent that a large proportion of the extracted honey sold in the retail stores of the State is honey shipped in from outside sources. The beekeepers as a whole do not know how to handle extracted honey or how to prepare this product for market. According to a survey of 100

stores which was made during 1931 and 1932 only eighteen stores of the 100 carried extracted honey produced in Pennsylvania. Of the eighteen, five carried honey produced in other states.

A large part of the time has been used to develop permanent demonstration apiaries, and 4-H bee clubs, control foulbrood and conduct the demonstration work for the improvement of management methods and marketing programs.

The permanent demonstration apiaries have been established in many sections of the State. When a progressive beekeeper is found who wishes to develop as a beekeeper his apiary is often selected for a permanent demonstration apiary. The needs of the community, the location of the apiary and the personality of the beekeeper are all considered before the apiary is finally selected.

A series of demonstrations are held at the demonstration apiaries each year until methods used in the apiary and in the community justify the discontinuance of the apiary for demonstration work.

The first demonstration in one newly selected apiary may be the transferring of bees from crosscomb or odd sized hives to new standard equipment. In another, the first demonstration may be a requeening demonstration in an apiary where everything is standard and up to date in appearance.

The following demonstrations are given during the season according to the needs of the apiary.

1. Introducing package bees.
2. Requeening.
3. Clipping the queens.
4. Swarm control practices.
5. Fall and spring feeding.
6. Winter protection.
7. Extracting.
8. Grading.
9. Marketing.

Quite often requests are made at these demonstrations by beekeepers attending for demonstrations on special problems in other communities. These requests are taken care of if possible and as a result the program in the county is developed and extended. The demonstration apiaries are generally carried on for three or more years, since there are many steps in management which can not be handled during the first year or two of work in the community.

The disease control work is insofar as possible conducted on a com-

munity cleanup basis. The nature of the foulbrood with its ability to spread for miles from a diseased apiary makes a community program necessary if any degree of success is to be obtained.

Generally this type of work in any community is started with a demonstration on disease control. All the infected colonies in the apiary are treated and the beekeepers in attendance are taught how to recognize the disease in its early stages, the demonstration shows them how to handle the disease after it is found. All present are urged to keep their own bees clean and encourage their neighbors to do likewise. Those beekeepers in attendance who do not feel capable of successfully treating their own bees and request assistance are given the needed help if time permits.

My observations indicate that most beekeepers prefer to keep their bees free from disease and that their failure to do so has been due largely to their ignorance of the presence of the disease in their apiaries or to their lack of knowledge of the proper method of treating the disease when found. The demonstration gives them the needed information.

The extracting and marketing demonstrations begin in spring when the management recommendations are made for the season. Hints for producing fancy comb honey are given. They include the use of No. 1 sections, the use of parafine on the sections, the development of strong colonies, and proper crowding in the section supers to insure well filled sections.

Beekeepers are urged to use shallow frame supers to hold the first surplus honey of spring. Then later they are given information on extracting the honey produced in the shallow frames. If necessary a demonstration is conducted to show how to build an extractor and make the accessories to complete the extracting equipment. Later a demonstration is given on extracting the honey. When the extracting is done information is also given for straining, bottling and care of the extracted honey.

Finally information is presented on marketing so the beekeeper will have an idea of the size and style of container to use for his product. One-half and one pound jars and 2½ and 4 pound tins are recommended. Ways and means of finding a market must also be discussed since many beekeepers encounter some difficulty in marketing their first crop of extracted honey.

Outlets for this type of honey are mentioned and the services normally expected from the producer are discussed. Special mention is made of the need of replacing crystallized honey in glass or damaged sections occasionally found on the shelves or counters of stores or roadside

markets. The survey made in 1932 showed that broken sections were present in 40 per cent of the stores carrying comb honey.

The 4-H club work has shown the greatest growth of any phase of the beekeeping extension work during the past five or six years. The clubs serve the purpose of a demonstration apiary in sections where established. The young folks generally take a real interest in their new line of work and get unusually good results. The older beekeepers see the results obtained and adopt the methods used by the club members.

The club members start either with their old hives or buy new equipment and a two pound package of bees. They are given a number of visits, generally five during the season, to check the development of the colonies and outline their plan of work for the next month or two. When the season is nearly over they get together and help build an extractor. Each member keeps a record of costs and returns so that when the season's work is finally completed he knows what his profits or losses may be and the actual cost per pound for producing the honey. The last step of the season is for the club members to show their products at a club roundup held sometime during October or November. At the roundup an educational program is arranged generally with some entertainment. Each member shows six sections and six one-pound bottles of honey. Prizes and ribbons are awarded on the basis of production, records, and exhibits.

The program of work throughout the season has been developed and arranged so that each member gets information in producing and marketing both comb and extracted honey.

The young folks with their enthusiasm become a real factor in the control of foulbrood in their communities. They are as a rule insistent in their demands that the community be kept free from disease and they are generally willing to help clean up the disease.

TABLE 1. SUMMARY OF 4H CLUB WORK SINCE, 1927

	No. clubs	Members	Meet.	Attendance	Roundups	Attendance
1927	2	11	4	29		
1929	8	71	22	407	6	68
1931	14	219	47	1017	8	1820
1933	25	267	83	1203	12	844

TABLE 2. SUMMARY OF 4H CLUB RESULTS, 1933

No. of members	267	
No. colonies of bees	312	
Total production	29,796	pounds
Average per colony	95.5	"
Total profits	$3,456.96	
Profits per colony	11.08	
Cost per pound	.05	
Average market price	.15	

A better idea of the development of the work and the results obtained can be had from Tables 1 and 2 which show the growth of the 4-H bee clubs during the past six years and the results obtained by the club members during 1933.

STUDIES ON THE CONTROL OF GRANULATION OF IOWA HONEYS[1]

By Ellis I. Fulmer, Wouter Bosch, O. W. Park and J. H. Buchanan

In our progress report[2] of last year there were presented data on the levulose-dextrose ratios and water contents of over twenty types of honey. It has been generally considered that the higher the levulose-dextrose ratio, the less the tendency toward granulation. When the honeys studied by us were grouped into the three classes of rate of granulation, rapid, slow, and rare, it was found that while in general the higher the levulose-dextrose ratio, the slower the rate of granulation, there were a few marked exceptions. It was noted also that, in general, higher water content favored stability; however, there were exceptions.

From a chemical viewpoint, honey may be considered to be a supersaturated sugar solution, together with certain other materials such as dextrin, minerals, proteins, acids, pollen grains and so on. It is obvious, then, that the addition of water should dilute the honey so that it would no longer be a supersaturated solution, and hence should not granulate. From this point of view it would remain to be determined whether the amounts of water which must be added to accomplish this purpose would be excessive. Too large an addition of water would interfere with the body of the honey and would also lead to difficulties due to fermentation. The water content of the honey should not be more than 20–21% to meet these requirements.

The various chemicals which were tested as to their effect upon the granulation of honey included gelatin, gum arabic, sodium carbonate, trisodium phosphate, sucrose (cane sugar), lactose (milk sugar), levulose (fructose), dextrose (glucose) and water. The choice of each chemical of this list was based upon a known specific effect upon crystallization in general. Of these factors, only two, the influence of

[1]Journal Paper No. J142 of the Iowa Agricultural Experiment Station, Ames, Iowa. Project No. 355.

[2]Bosch, Wouter, E. I. Fulmer and O. W. Park, 1933. Studies on honeys and nectars. (Iowa) St. Apiarist Rept., 1932: 52–56.

the levulose-dextrose ratio and the water content will be considered in this report. The results with the other chemicals were significant and verified the reasoning back of their choice and will be considered in a later communication. The levulose-dextrose ratio and water content are chosen for the present discussion because their use does not involve the addition of any material foreign to natural honey.

THE INFLUENCE OF LEVULOSE-DEXTROSE RATIOS ON THE RATE OF GRANULATION OF VARIOUS HONEYS.—Varying amounts of pure levulose or dextrose were added to the several honeys. The solutions were added in such strength as not to change the water content. After the addition the samples were heated for 3 hours at 50° C. This heating process not only effected the usual pasteurization but also brought into solution any sugar crystals that might cause nuclei for granulation.

One series of samples was "seeded" with a small amount of dextrose in order to hasten crystallization. The other series was not seeded. The following honeys were so studied: basswood, buckwheat, catsclaw, cotton, dandelion, eucalyptus, fireweed, gallberry, horsemint, mesquite, orange, palmetto, sage, sourwood, sweet clover, tupelo, and white clover.

TABLE 1. GRANULATION STATUS OF SEVERAL HONEYS, AFTER 14 MONTHS, WITH VARIOUS LEVULOSE-DEXTROSE RATIOS

	Not seeded with dextrose					Seeded with dextrose				
Honey	Fi32	Or32	SC32	T32	WCl32	Fi32	Or32	SC32	T32	WCl 32
Per cent water	16.3	16.5	15.3	15.1	16.8	16.3	16.5	15.3	15.8	16.8
L/D	1.14	1.20	1.04	1.70	1.11	1.14	1.20	1.04	1.70	1.11
0.90	–	1	–	–	–	–	3	–	–	–
1.00	2	0	–	0	0	5	2	–	1	–
1.10	1	0	0	0	0	2	1	2	0	–
1.20	0	0	0	0	0	1	1	2	0	–
1.30	0	0	0	0	0	0	0	1	0	2
1.40	0	0	0	0	0	0	0	1	0	0
1.50	0	0	0	0	0	0	0	1	0	0
1.60	–	–	–	0	0	–	–	–	0	0
Orig.	–	–	–	–	–	2	1	1	0	2

Fi = fireweed Or = orange Sc = sweet clover
T = tupelo WCl = white clover

The number 32 signifies honey of the 1932 crop.
L/D refers to the levulose-dextrose ratio.

In table 1 are given data on the status of five honeys after 14 months. These are the honeys in which the levulose-dextrose ratios were such as to show some differences in granulation. The degree of granulation is expressed arbitrarily in terms of the numbers 1, 2, 3, 4 and 5; number 1 representing the first evidences of granulation. In the cases of fireweed and orange honeys the effect of varying the levulose-dextrose

ratio is apparent in the unseeded as well as in the seeded series while with the sweet clover, tupelo and white clover honeys, the effect is apparent only in the seeded series. This latter shows the advantage in using the seeding method to hasten results. The tupelo honey is one of the most stable types studied, the water content being 15.1% and the levulose-dextrose ratio 1.70. This is the highest levulose-dextrose ratio of any of the honeys which we have examined. It is very interesting, then, to note the beginning of granulation at the levulose-dextrose ratio of 1.00 in the seeded series.

It is evident, then, that for a given honey, the rate of granulation can be altered by changing the levulose-dextrose ratio, although, as has been stated before, for different honeys, there is not always a direct correlation between this ratio and granulating tendency.

THE INFLUENCE OF WATER CONTENT UPON THE RATE OF GRANULATION OF VARIOUS HONEYS.—As noted previously, the rate of granulation of honey is, in general, less with increasing water content. From the data presented in our previous report, the lowest water content was 9.9% for cotton honey, while three of the honeys ran 20.0% or above; dandelion, 20.0%; gallberry, 20.5%, and mesquite, 20.6%. The average water content of the honeys examined was 16.7%.

The above analyses were obtained by the usual long and tedious method of drying the samples on sand in a vacuum. The authors have since then developed a very rapid procedure for the determination of the water content of honeys, the details of which are being published elsewhere. The procedure involves the determination of the refractive index of the honey by means of the Abbé refractometer. The water content is read from a table showing the relation between refractive index and water content of honey. By this means the moisture content of honey may be determined in a few minutes instead of the 24 hours required by the old method.

In studying the influence of water content on granulation, varying amounts of water were added to each honey and the samples heated for 3 hours at 50° C. One series was seeded and the other was left unseeded, for observation. The following honeys were so treated: alfalfa, basswood, bitterweed, buckwheat, catsclaw, cotton, dandelion, eucalyptus, fireweed, holly, horsemint, heartsease, heartsease with Spanish needle, mesquite, palmetto, sweet clover, and white clover.

The influence of water content on the granulation of cotton honey is especially interesting. As noted previously the water content of this honey, as received, was 9.9% with the low levulose-dextrose ratio of 1.07. As would be expected, it was exceedingly unstable. Various

amounts of water were added and the honey heated as above described. After 14 months there are a very few crystals on the bottom of the sample containing 17.6% water and there is no evidence, whatsoever, of crystallization at 19.6% water.

Of honeys having average water content, sweet clover honey was the least stable; its water was 16.8%, its levulose-dextrose ratio the low value of 1.02. In table 2 are given data showing the status of this honey, with various water additions, up to and including a period of 22 months. The data show clearly two facts; the successive additions of water slow down the rate of granulation; the heating alone will not accomplish this effect, for all the samples had been heated 3 hours, at 50° C. As stated previously, the granulation value of 1 may indicate only a slight degree of crystallization or, at most, a visible deposit. It should be noted also that, for water concentrations above 18.7%, after the granulation value of 1 has been reached, there is no further change during a year or more. It should be emphasized that, of all the honeys studied by us, granulation was most difficult to control in the case of this particular honey.

TABLE 2. GRANULATION OF SWEET CLOVER HONEY (SC 31 (2) —) TO WHICH 1–10% OF WATER HAD BEEN ADDED

Original water content = 16.8
Levulose-dextrose ratio = 1.02

Per cent water	Months											
	1	2	4	6	8	10	12	14	16	18	20	22
17.7.....	0	2	4	5	4	4	4	5	5	5	5	5
18.7.....	0	1	2	2	2	2	2	2	2	2	2	2
19.7.....	0	0	1	1	1	1	1	1	1	1	1	1
20.6.....	0	0	0	1	1	1	1	1	1	1	1	1
21.5.....	0	0	0	0	1	1	1	1	1	1	1	1
22.5.....	0	0	0	0	1	1	1	1	1	1	1	1
23.3.....	0	0	0	0	1	1	1	1	1	1	1	0
24.2.....	0	0	0	0	1	1	1	1	1	1	1	0
25.0.....	0	0	0	0	0	1	1	1	1	1	1	0
25.9.....	0	0	0	0	0	1	1	1	1	1	1	0

NOTE: A rating of 1 means that granulation is limited to a thin film of small crystals or perhaps a few large ones on the bottom of the jar, which does not affect the general appearance or salability of the product. Complete granulation is indicated by a rating of 5.

It is evident that for each honey there is a water content which will just prevent granulation. None of the honeys studied by us showed more than a trace of granulation at 20% water content, while many of the honeys remained stable at lower values. This maximum water content of 20%, required to stabilize the most rapidly granulating honeys, is within the range of water content of natural honeys. This concentration does not seriously affect the body of the honey nor is it high enough to

increase the hazard of fermentation, provided the honey is properly pasteurized.

The process used for preventing the granulation of honey consists simply in adjusting the moisture content to the appropriate value, followed by pasteurization for 3 hours at 50° C.

STUDIES ON THE BACTERIA ASSOCIATED WITH EUROPEAN FOULBROOD

By C. E. BURNSIDE, *Assistant Apiculturist, Bureau of Entomology, United States Department of Agriculture*

The etiology of European foulbrood of bees is an unsettled problem, several theories having been advanced regarding the cause of this disease. In 1885 Cheshire and Cheyne *(2)* described *Bacillus alvei,* which they claimed was the cause of the brood disease now known as European foulbrood. In 1907 Maassen *(9)* stated his belief that the etiology of the mild form of foulbrood (European foulbrood) is not uniform but that the disease is caused principally by *Streptococcus apis* and *B. alvei.* White *(11, 12, 13)* was unsuccessful in attempts to produce typical European foulbrood with cultures of *B. alvei, S. apis,* or *Bacterium eurydice* and concluded that this disease is caused by a new species, *Bacillus pluton* White, which failed to grow on artificial media. Borchert (*1 p. 12*) and Lehmann and Newman (*4 p. 236*), of Germany, have pointed out that uncertainty still exists concerning the etiology of European foulbrood. Wharton *(14)* reported having cultured *B. pluton* and producing infection in a colony of black bees by inoculation with cultures derived from primary colonies. Lochhead *(5)* says that this organism cultured by Wharton "appears to be closely related if not identical with *Streptococcus apis* described by Maassen." Wharton *(14)* also says that "cultures of *B. pluton* have been observed to change to *B. alvei* form resembling biologically the *B. alvei* isolated from infected larvae." Lochhead *(5, 6)* reported the origin of a coccoid bacillus in cultures of *B. alvei.* The coccoid was isolated and stabilized and is said to have "all the appearance of what White calls *Bacillus pluton.*" Both Lochhead and Wharton question the secondary-organism theory of White as regards European foulbrood.

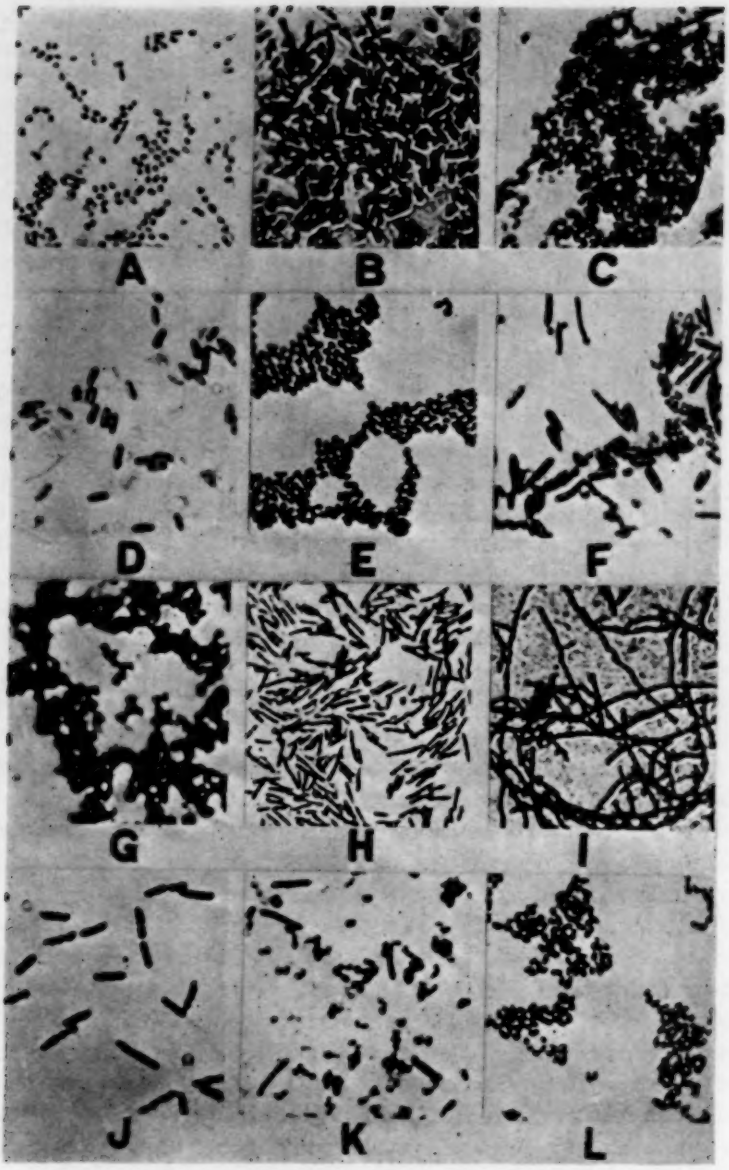
At the time White conducted his studies on European foulbrood it was generally believed that bacterial species remain constant in morphological and cultural characteristics. In recent years evidence has been constantly increasing that bacteria are capable of morphological,

cultural, and biological transformation, and the old doctrine of fixity of bacterial species is gradually giving way before this evidence. Chief among the investigators in this field is Mellon, whose extensive works have demonstrated that many species of bacteria, when cultured under different environments, produce mutants and variants with greater frequency than is commonly supposed. Works of Mellon, Hadly (*3*), Löhnis and Smith (*7, 8*), and others strongly indicate the existence of life cycles among bacteria similar to life cycles among the fungi. Mellon (*10*) has aptly stated what seems to be the situation in the following quotation: "Thus the analogy is complete, constituting rather formidable evidence for our contention that biologically bacteria may be properly regarded as fungi which have been telescoped down into a state of existence where their life cycles, although much compressed and often abbreviated, are still not obliterated."

In 1928 the writer started observations and experiments on European foulbrood to obtain evidence in support of one or another of the theories regarding the cause of this disease. He repeated experiments of others but sometimes interpreted them differently, and he also performed new experiments. Experimental results were not always so conclusive as might be desired and the significance of observations was not always apparent. Observations and experimental results which may aid, directly or indirectly, in arriving at a true conception of the etiology of European foulbrood are reported in this paper.

MORPHOLOGY OF BACTERIA IN AFFECTED BROOD.—Wide variation was observed in the morphology of bacteria present in sick or dead brood. (Plate 6, *A*, *B*, and *C*.) In recently infected larvae the bacteria were mostly very short rods occurring singly, in pairs, or in short chains. Medium-long rods were sometimes present, but no distinctly pointed cells were found during early infection. As the disease progressed and bacteria increased in number, variability in their morphology increased. Most frequently coccoid cells predominated, but at times moderately long rods were equally numerous. Cells of the *B. pluton* type (Plate 6, *C*) originated from the coccoid cells at about the time multiplication of bacteria was checked by overcrowding. The pointed condition appeared to be an expression of dormancy, since these cells usually occurred singly in coherent masses with rarely any indication of active division. In very late infection pointed cells usually predominated, but among different larvae and different colonies the proportion ranged from 10 per cent or even less to nearly 100 per cent. In some larvae coccoid cells predominated (Plate 6, *A*), in others moderately long rods were most numerous (Plate 6, *B*), and occasionally long, slender, faintly staining

Plate 6



BACTERIAL FORMS FROM LARVAE INFECTED WITH EUROPEAN FOULBROOD
(x 1,500)

A, *B*, and *C*, Smears from the stomach of different larvae in an advanced stage of infection, showing difference in morphology of the bacteria. In *A* only a few

rods were present in small numbers (Plate 6, *C*). Thus it is apparent that the morphological forms encountered in sick larvae present a complex and variable picture.

When bacterial growth occurred after death of larvae, it usually consisted almost entirely of moderate-sized rods, of which a variable percentage formed spores of *B. alvei.* (Plate 6, *D.*) Occasionally coccoid bacilli indistinguishable morphologically from bacilli that grow in the digestive tract of sick larvae caused decay of the body tissues after death. In still other larvae decay was caused by both the rod and the coccoid form.

CULTURES FROM SICK OR DEAD BROOD YIELDED DIFFERENT MORPHOLOGICAL FORMS.—Rough inoculation of bouillon agar slants from sick or dead brood most frequently yielded cultures of *B. alvei* which sporulated promptly. Many cultures, particularly those prepared from the digestive tract of larvae in an early stage of infection, yielded a coccoid organism in apparently pure culture which morphologically and culturally closely resembled *S. apis,* and there seems to be little doubt that it is identical with the form described by Maassen (*9*) in 1908 and later studied by White (*11, 12, 13*), Wharton (*14*), and Lochhead (*5*). On egg-yolk agar many cells of this form become lancet-shaped and were

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of the cells are still dividing; the majority are coccoid with rounded ends, while some are more or less pointed. In *B* the coccoid cells, short rods, and medium long rods are about equally numerous. In *C* most of the cells have pointed ends and are typical of the type known as *Bacillus pluton;* two long, slender rods, such as occur in small numbers in infected larvae, are also seen.

D, Spores of *Bacillus alvei* from the decayed remains of a larva dead of European foulbrood.

E, Pure culture of *Streptococcus apis* from agar culture containing unheated egg yolk. In some cultures 50 per cent or more of the cells become more or less pointed and are indistinguishable morphologically from *Bacillus pluton.*

F, Bacillus alvei and *Streptococcus apis* from an agar culture prepared directly from a sick larva. (2 days at 36° C.)

G, Streptococcus apis from a culture prepared directly from a sick larva in brood filtrate. (2 days at 36° C.)

H, Asporogenic agar culture of *Bacillus alvei,* which morphologically closely resembles *Bacterium eurydice.* (5 days at 20° C.)

I, Threadlike rods from an asporogenic agar culture of *Bacillus alvei.* (17 days at 20° C.)

J, Rods from an asporogenic bouillon-agar culture of *Bacillus alvei* with beaded and granular protoplasm. (5 days at 36° C.)

K, Culture of *Streptococcus apis* in bouillon broth, showing rods of *B. alvei* which appeared after 6 days at 36° C.

L, Pure culture of *Streptococcus apis* from bouillon agar to which 10 per cent honey was added. (36° C.)

indistinguishable morphologically from *B. pluton.* (Plate 6, *E.*) Many cultures yielded both *B. alvei* and *S. apis.* (Plate 6, *F*) In some cultures the cells of the coccoid form were observed to be dissociated. Occasional cultures of *B. alvei* prepared from sick or dead brood—the relative number varied in different samples of infected brood comb—grew slowly and sporulation was delayed and incomplete. In a few instances rough inoculation from affected brood yielded cultures of rods which did not form spores at all when cultivated at room temperature. Cultures of asporogenic rods were also obtained, some of which closely resembled *B. eurydice,* by plating directly from sick larvae at room temperature.

In a few cultures on bouillon agar or egg-yolk agar prepared with bacteria from the digestive tract of sick larvae no growth was detected. From the same larvae, however, prompt and abundant growth was obtained in dilute sterile filtrate prepared from macerated honeybee larvae. In filtrate medium a coccoid organism resembling *S. apis* (Plate 6, *G*) was usually obtained, but some cultures yielded also small or moderate-sized rods. It is evident that failure to obtain growth on ordinary nutrient agar does not prove the absence of culturable bacteria.

Cultures from healthy-appearing larvae from different infected colonies yielded in a variable percentage of the tubes apparently one or another of the same forms obtained in cultures from sick or dead larvae (*B. alvei* or *S. apis*). When combs of brood were removed from colonies shortly after infection had subsided and were kept either at room temperature or at 36° C., none of the larvae dying of starvation or chilling were noticeably decayed by *B. alvei,* even though this organism was found by cultural tests to be present in the digestive tract of more than 90 per cent of them.

Bacteria Present in Honey from Infected Colonies.—*Bacillus alvei* was found to be abundant in honey and pollen from the brood chamber of infected colonies. In advanced cases inoculations of nutrient agar with a single loopful of honey (about 0.001 cc) practically always yielded *B. alvei,* while a few also yielded *S. apis.* In early or mild cases part of the cultures prepared with honey or pollen yielded *B. alvei.*

Bacteria Found in Colonies with European Foulbrood Not Present in Healthy Colonies.—In striking contracts to the prevalence of bacteria in larvae from infected colonies is the complete absence of these forms in healthy colonies. The writer has made microscopical examinations of and prepared cultures numbering well into the thousands from larvae dead of American foulbrood, sacbrood, fungus diseases, plant poisoning, and other brood disorders, as well as from healthy larvae,

without having found or obtained *B. alvei* or *S. apis* in culture, except on rare occasions when mixed infection was suspected. Likewise cultures prepared with honey and pollen from healthy colonies in which European foulbrood never existed have never yielded *B. alvei.*

The writer's observations on this point differ from those of Maassen (*9*), who claims to have found *B. alvei* present in some cases in larvae dead of "virulent foulbrood" (American foulbrood). In a few cases the writer obtained *B. alvei* in cultures from combs infected with American foulbrood, but a thorough inspection of the brood comb and of the scales used in preparing the cultures generally revealed mixed infection and occasionally a scale of European foulbrood which resembled that of American foulbrood. It seems possible that Maassen may likewise have been dealing with cases of mixed infection.

TRANSMISSION OF EUROPEAN FOULBROOD WITH CULTURES.—When conditions are favorable, typical European foulbrood is readily transmitted by inoculation with bacteria taken from the digestive tract of sick or dead brood. On the other hand, typical European foulbrood has only rarely been produced by inoculation with cultures, although several investigators, in inoculation experiments with cultures of *B. alvei* (rods and spores), have obtained an atypical infection. In the writer's experiments an occasional larva or pupa was attacked by *B. alvei* when a water suspension of sporulating cultures recently isolated from infected brood was sprayed over developing brood. It appears that *B. alvei* in the usual sporogenic state may, under favorable circumstances, produce disease in larvae or pupae, but this disease is not typical European foulbrood.

Likewise, attempts to produce European foulbrood by inoculation with pure cultures of *S. apis* have usually been unsuccessful. Maassen (*9*) failed to demonstrate pathogenesis for *S. apis* by feeding pure cultures, and White (*12*) states that "No disease results when the brood of bees is fed cultures of *Streptococcus apis* either by the direct or indirect method." In speaking of the coccoid form of *B. alvei,* Lochhead (*6*) states, "Our attempts to produce the disease in a colony of black bees through feeding cultures of the coccus have so far been inconclusive." On the other hand, Wharton (*14*), in inoculation experiments with cultures of a coccoid bacillus which Lochhead (*5*) says "appeared to be closely related to, if not identical with, *Streptococcus apis,*" claims to have produced typical European foulbrood. Concerning this experiment Wharton says, "The writer has obtained infection in a healthy colony of black bees in four days, using as inoculum cultures of the organism derived from isolated colonies. The symptoms of the diseased larvae

accorded with those observed in naturally infected larvae and the microscopical picture was typical—*B. alvei* forms being also present, though only in small numbers." If Wharton's cultures were pure, as he assumes, to him belongs the credit of first producing typical European foulbrood by inoculation with pure cultures.

The writer's inoculation experiments with *S. apis* and with non-spore-forming rod cultures (resembling *B. eurydice*) isolated from sick or dead brood gave results that were largely negative or inconclusive. On one occasion typical European foulbrood was produced by inoculation with cultures of *S. apis* freshly isolated from sick larvae. In isolating pure cultures plating was ordinarily done two or more times. Occasionally larvae inoculated with such cultures appeared to become infected and were removed by the bees, but the symptoms were not typical of European foulbrood and the infection disappeared promptly.

In an experiment performed in 1933, bacteria from the digestive tract of a naturally infected larva were streaked on egg-yolk-agar plates. After 24 hours at 34° C. isolated colonies of *S. apis* were touched with a platinum loop and cultures were prepared on egg-yolk-agar slants. With the abundant growth obtained on these slants after 44 hours at 36° C., a colony of black bees was inoculated by spraying the bacteria, in water suspension, over two combs of young and hatching larvae. Two days later numerous coccoid bacteria were found within the digestive tract of some of the larvae. On the following day coccoid bacteria had greatly increased in number in many of the inoculated larvae and larvae were being removed rapidly by the bees. On the fourth day more than 90 per cent of the inoculated larvae had been removed. None of those remaining showed outward symptoms, but upon microscopical examination coccoid bacteria morphologically identical with the bacteria in the inoculum were so abundant within the digestive tract that infection could be definitely ascertained. All the unsealed brood in the inoculated combs was finally removed by the bees and no dead larvae were found in the cells.

A water suspension of bacteria from the artificially infected larvae was next sprayed over another comb of young brood in the same colony. After 3 days fully 25 per cent of the inoculated larvae in this comb were dead or dying from infection, of which the gross symptoms and the bacteriological picture were typical of European foulbrood. Pointed or lancet-shaped cells (*B. pluton*) were at first absent or present only in small numbers, but later they became numerous. The coccoid bacillus was reisolated, but out of about 100 cultures *B. alvei* was obtained in only one. With cultures prepared by rough transfer from those with

which infection was obtained three succeeding experiments gave negative results. The results of this experiment and the comparable experiment performed by Wharton (*14*) seem to point to retention of virulence by *S. apis* during only about two generations on artificial culture media. It is recognized, however, that the purity of such recently isolated cultures may be questioned.

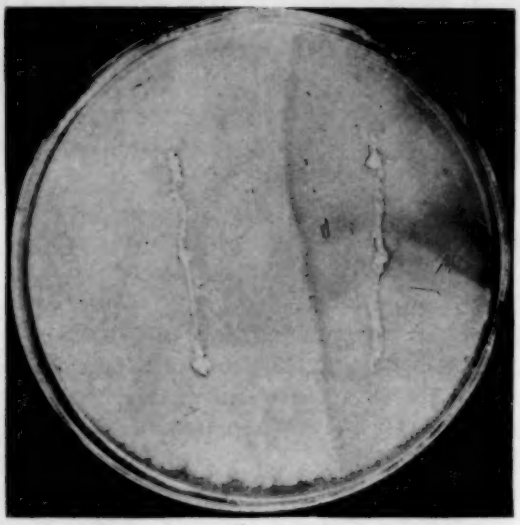
PLEOMORPHISM AND VARIABILITY IN *Bacillus alvei*. Several investigators have observed variation in size and shape of individual cells in cultures of *B. alvei*. Maassen (*9*) says that cultures of *B. alvei* degenerate on the usual artificial medium and that nuclei or granules develop in the plasma while the ability to form spores disappears. Lochhead (*5, 6*), using a special nutrient agar, observed the origin of coccoid cells from rods of *B. alvei*, which he reported (6) to be indistinguishable morphologically from *B. pluton*.

In the writer's experiments *B. alvei*, in the form in which it is usually isolated from dead brood, grew luxuriantly, spread rapidly over the agar, and formed spores promptly and abundantly on bouillon agar and on egg-yolk agar at 36° C. (Plate 7, *A*.) In repeated transfers at 36° C. on these agars no morphological or cultural changes were observed. In bouillon broth, potato broth, and milk, and in media containing sterile filtrate prepared from honeybee larvae, the luxuriance of growth and the tendency to form spores gradually decreased in repeated transfers. After about 10 generations in potato broth, cultures prepared by rough transfers to bouillon agar and egg-yolk agar grew slowly while sporulation was incomplete and delayed or lacking. Growth either spread slowly or was confined to small colonies. (Plate 7, *B*.) By planting and culturing from isolated colonies, strictly asporogenic cultures were obtained which in repeated transfers remained asporogenic. When cultured at room temperature the transformation in potato broth from a sporogenic to an asporogenic condition was more rapid. Bouillon broth seemed less effective in producing the change, and results with filtrates from honeybee larvae were irregular.

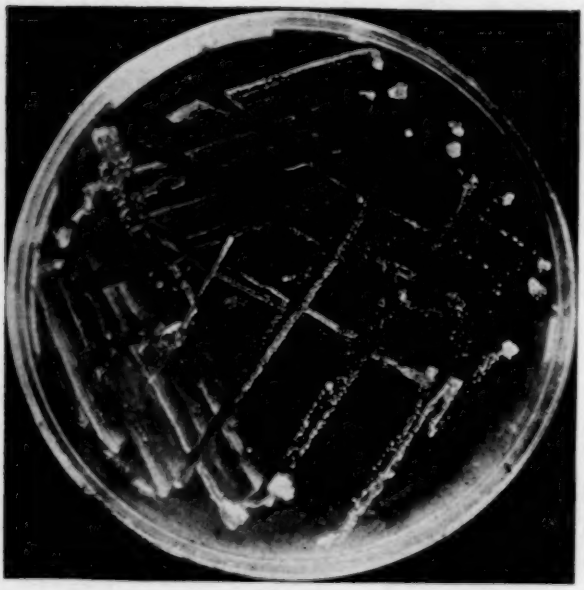
These asporogenic cultures of *B. alvei* varied in morphology and cultural characteristics (Plate 6, *H, I, J*), but in some cases the resemblance to cultures of asporogenic rods isolated by plating from sick larvae was marked. It seems probable, therefore, that *B. alvei* may exist in infected larvae in either sporogenic or asporogenic condition.

Morphologically and culturally the characteristics of some of the cultures were indistinguishable from the characteristics given by White (*11*) for *B. eurydice*. (Plate 7, *B;* plate 6, *H*.) Concerning this form White (*13*) says: "In studying this species cultures were isolated which

Plate 7



A



B

TYPES OF GROWTH OF BACILLUS ALVEI

A, Two spreading colonies of *Bacillus alvei* on a bouillon-agar plate, showing difference in type of growth.

B, *Bacillus alvei* on glucose-agar plate growing in small colonies after transformation from a sporogenic to an asporogenic condition.

in some respects differed from it. Whether these are different species or belong to a group of which *B. eurydice* is a representative has not been definitely determined." Concerning methods of culture White further says: "Incubation must be carried out at room temperature. Growth of the species is always slow and never luxuriant." In view of the writer's observations it seems probable that the culture described by White as *B. eurydice* and cultures which "in some respects differed from it" may have been asporogenic variants of *B. alvei*.

The variability of *B. alvei* in morphology and cultural characteristics appeared to depend upon the physiological condition of the organism as well as upon the culture medium. To retain viability of cultures frequent transfers were necessary. The description of the organism given below is of cultures produced as follows: Agar slant cultures of sporogenic *B. alvei* were prepared from isolated colonies. A water suspension of spores was boiled for 3 to 5 minutes, after which the organism was cultured by transferring for 10 generations in potato broth. Cultures prepared from isolated colonies on agar plate by transfer to nutrient agar on which sporulation is ordinarily prompt were then asporogenic at room temperature.

Glucose-agar plate.—Colonies slightly convex and rounded with uniform outline, 1 to 2 mm in diameter, grayish by reflected light, bluish gray by transmitted light; under a binocular appearing very light brown and finely granular.

Morphology.—Variable; rods nonmotile and asporogenic, occurring singly, in pairs, or in chains, ends rounded; protoplasm homogeneous or granular or broken; smaller and more slender than sporogenic *B. alvei* in some cultures, of equal dimensions in others.

Staining properties.—Stained readily with the usual dyes and Gram-negative; granules sometimes darkly staining and Gram-positive.

Oxygen requirements.—Growth occurring under anaerobic conditions but more luxuriant in the presence of air.

Bouillon.—Medium slightly clouded after 48 hours, a slightly viscid sediment forming slowly at bottom of tubes.

Sugars.—With the usual sugars acid but no gas produced; both arms of tube clouded, but growth most luxuriant in open arm; litmus discharged.

Brood filtrate.—In some cultures brood filtrate added to the medium increased growth, but in other cultures no effect observed; growth also variable in water solution of filtrate.

Milk.—Slight growth with little or no change apparent in either litmus milk or plain milk.

Potato broth.—Growth slow, with slight uniform clouding and slight sediment.

Potato.—Feeble, grayish growth.

Gelatine stab.—No liquefaction.

In asporogenic cultures of *B. alvei* coccoid bodies were observed which morphologically resembled the coccoid bodies observed by Lochhead (*6*), but attempts to isolate this form have thus far been unsuccessful.

In recently formed asporogenic cultures the protoplasm (from bouillon or glucose agar) was usually homogeneous. After several transfers, especially on egg-yolk agar, the protoplasm often became granular or broken. At times the rods assumed a beaded appearance resembling chains of coccoid cells. One culture in brood-filtrate medium assumed a decided coccoid appearance with many forms indistinguishable morphologically from chains of coccoids observed in cultures of *S. apis*. Rods were frequently observed in a state of dissociation, and in some cultures few rods remained undissociated after 4 or 5 days' incubation.

PLEOMORPHISM IN *Streptococcus apis*. — On ordinary bouillon agar *S. apis*, when freshly isolated, appears in diplococcoid form with occasional single cells and short chains. The cells are only rarely spherical, their length being usually aproximately 1½ times their thickness. In bouillon broth the tendency to grow in chains is accentuated, while on nutrient agar containing egg yolk the cells are smaller than in bouillon agar and appear singly or in pairs. The ends are sharply rounded and frequently pointed, many forms being morphologically indistinguishable from *B. pluton*. In some of the cultures on egg-yolk agar approximately 50 per cent of the cells became more or less pointed after multiplication ceased. (Plate 6, *E*.) After prolonged cultivation further changes in morphology have been observed from time to time.

Wharton (*14*) reported that his morphological studies suggest the identity of *B. pluton* and *B. alvei* and stated that "Cultures of *B. pluton* have been observed to change to *B. alvei* form, resembling biologically the *B. alvei* isolated from infected larvae." In a few instances the writer's cultures of *S. apis* derived originally from isolated colonies have yielded rods (Plate 6, *K*) and eventually spores of *B. alvei*. This has been observed only in broth cultures prepared by transfer from old cultures on nutrient agar. After incubation for 7 to 12 days at 27° C., rods of *B. alvei* appeared in small numbers, but nothing was determined concerning their origin. Spores were produced in the original broth cultures and in transfers on nutrient agar. On other occasions rods that failed either to grow or to produce spores in transfers originated in broth cultures. Occasionally rods with length equal to about five times

their thickness, shorter rods, coccoid cells, and lancet-shaped cells were observed in the same chains in broth cultures of *S. apis*. In cultures on bouillon agar to which 10 per cent honey was added, some of the cells were increased in size, many were distinctly rod-shaped, while others assumed lancet shapes indistinguishable from *B alvei* (Plate 6, *L*). In broth cultures of *S. apis* containing both honey and unheated egg yolk, several variants were observed after 2 days, including large, irregular, barrel-shaped, and spherical cells, occurring usually in pairs or in chains.

CONCLUSIONS.—Several morphologically different bacteria forms are more or less constantly present in honeybee larvae sick or dead of European foulbrood. These forms are absent in larvae sick or dead of other causes.

No evidence has yet been obtained which satisfactorily explains the etiology of European foulbrood or why these different bacterial forms are constantly associated with this disease.

It has been found that *Bacillus alvei* is capable of morphological, cultural, and biological transformation and is also capable of stabilization, at least temporarily, as a sporogenic rod, an asporogenic rod resembling *Bacterium eurydice*, or a coccoid resembling *Bacillus pluton*.

There seems to be insufficient reason for assuming that the lancet-shaped bacterial cell, *B. pluton*, found in late stages of infection in European foulbrood, is of different genus and species from the similar form *Streptococcus apis*, which is readily obtained in culture from sick larvae.

The identity of *Streptococcus apis* and *Bacillus pluton* is suggested by morphological similarity, by the fact that the pointed or lancet shape is a variable character in both forms and appears to be only an expression of restricted growth or dormancy accentuated in infected larvae, and also by the usual, if not invariable, occurrence of *Streptococcus apis* in recently infected larvae, and by the fact that typical European foulbrood was produced in Wharton's and in the writer's experiments when young brood was inoculated with cultures of *S. apis* prepared with isolated colonies.

That *Bacillus pluton* and *Streptococcus apis* are variants, or stages in the life history, of *Bacillus alvei* is suggested by the occurrence of variants resembling *B. pluton* in pure cultures of *B. alvei* and by the apparent origin on rare occasions of sporogenic *B. alvei* in cultures *S. apis*.

The transformation at room temperature of sporogenic *B. alvei* into an asporogenic nonmotile rod which morphologically, culturally, and bio-

logically is closely allied to *Bacterium eurydice* likewise suggests the identity of these forms.

Regarding the etiology of European foulbrood and the variety of bacterial forms present in sick and dead larvae much remains to be determined. The writer is of the opinion that the evidence now available points more strongly to a pleomorphic organism as the etiological factor in this disease than to the secondary organism theory advanced by White.

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Section of Extension

Minutes of the Section of Extension of the American Association of Economic Entomologists held in Parlor C of the Hotel Bradford, Boston, Massachusetts, 7:30 P. M., Dec. 27, 1933.

Chairman—H. E. Hodgkiss, State College, Pennsylvania.

Secretary—M. P. Jones, Washington, D. C.

The meeting was opened by the Chairman, H. E. Hodgkiss. In the absence of the Secretary, W. E. Blauvelt, Ithaca, N. Y., was appointed Secretary pro-tem.

The minutes of the previous meeting were read by the secretary pro-tem.

The committee on nominations, appointed by the chairman, consisted of L. R. Dills, C. R. Crosby, and W. E. Britton. The committee recommended and the section elected as chairman for 1934, M. P. Jones, Washington, D. C., and as Secretary, W. E. Blauvelt, Ithaca, N. Y.

The Committee on resolutions presented the following which was unanimously adopted.

COMMITTEE ON RESOLUTIONS

WHEREAS, the arrangements for the meeting of the Extension Section of the Association were most satisfactory.

BE IT RESOLVED, that we express to Messrs. C. W. Collins, W. D. Whitcomb, and C. T. Brues our deep appreciation of their services in this connection, and to the American Association of Economic Entomologists for their cooperation in providing suitable facilities for the program.

AND BE IT FURTHER RESOLVED, that thanks of the section be extended to the management of the Hotel Bradford for their courtesies.

RAY HUTSON
PHILLIP GARMAN

PROBLEMS OF THE EXTENSION ENTOMOLOGIST

By H. E. HODGKISS, *State College, Pa.*

A discussion of the difficulties encountered by entomologists in the extension field offers a rather broad opportunity for either constructive or destructive criticisms. Under some conditions it might involve both extension and other workers in a rather active combat. However, since my ideas are assembled at the close of equal periods devoted to research and educational work, a balance ought to have been reached which should allow me to arrange an unbiased presentation of the subject.

EXTENSION WORK DEFINED.—The business of the extension worker is to inform the farmer about practices that will aid him to conduct his farm operations in a way that is both economical and profitable. The function of extension is not the impossible task of developing a multitude of meaningless formulae suitable to every conceivable situation. Extension is not a device to save the farmer the trouble of thinking. On the contrary, as our late Dr. Armsby stated in describing the function of the Experiment Station, "its consistent and insistent demand is that he think more." The true field of extension is in the farmer's mind and not on his farm.

ADMINISTRATION OF EXTENSION WORK.—There are two schools of thought with respect to the administration of extension activities connected with our State Colleges, which have agricultural extension work in charge. The one considers teaching, research and extension as a departmental unit. The other seeks to divide this responsibility to some extent and extension work is conducted on an administrative equality with the subject matter departments.

Under the first arrangement the head of the subject matter department is in charge of all phases of the work. If he is also scheduled to teach a number of courses his time is fairly filled. If his choice of a life work was teaching no doubt he has a tendency to develop the phase which has contributed so much to his collegiate standing. If on the other hand his experience has been entirely within the field of research it is natural to assume that the most of his interest will be along those lines. The same will be true of extension, or even regulatory operations if they also are included within the scope of his administration. It is to be expected that some phase of the work will languish from lack of sufficient interest or the one which has been developed highly will draw on the resources of the others for support.

In so far as extension work is concerned presumably the extension entomologist develops his own field. Under some arrangements that is probably true. It is also recognized that the younger man may need guidance in planning his work. But on the whole is not the incentive to progress dampened by the knowledge that in the last analysis the questions of policy must be referred to the teacher, the investigator, or the regulatory administrator who failing to have the viewpoint of the man on the firing line will not be able to analyze the situations correctly?

THE PROBLEMS IN ENTOMOLOGY EXTENSION.—As I see them, the outstanding problems are : (1) Proper organization; (2) the obtaining of insect control data; (3) the correct evaluation of the results of investi-

gations, and (4) the proper evaluation of the results of extension activities.

The organization of extension activities:—The proper development of educational work or of any other organization cannot be realized unless there is an objective. If there is no aim except the daily grind there can be no outstanding progress. The first essential, therefore, is to select a goal and bend every effort with that end in view. The one I selected was the establishment of Entomology on an equal footing in Pennsylvania with other sciences or arts having an agricultural category. If the selection of the objective was easy, its accomplishment was difficult of attainment. We have been at times rather discouraged, but it is significant that the closing weeks of the first decade registered its attainment in fact. The objective is still active since other sciences are pressing onward and even now we must strive to hold our present place in the structure with the same determination that brought about that earlier recognition.

Another factor is the organization of project activities. At the outset it was necessary for the state to be considered as a unit. With the initial survey completed and definite work established it was not possible to care for more than 40–44 counties during the year and complete the operations. As the personnel increased the project plan of handling the work was selected but after about three years was dropped on account of the duplication of effort that often occurred. In 1924 a plan of districting the state was devised and was so much more useful and less costly in operation that it has become a permanent arrangement.

Under the project plan the men did not take care of work other than might be assigned to them. They were inclined to overlook equally important items in the field. This was not broadening their perspective. Under the other scheme each specialist conducts all the operations in his territory. He plans his work accordingly and there are no conflicts. He has complete responsibility within his division, a better acquaintaince with the people, and has a much better chance to sense the insect control problems of these farmers. It gives him a wider range of experience and the added urge to round out this knowledge that makes his services much more valuable to us. As a result the amount of work done has increased each year and the freedom of action has never been abused.

Beekeeping is handled on a state-wide basis. The other plan is as well suited to this type of work although it has not as yet been found feasible to operate on that basis.

Another organization problem is the factor of time distribution. Should we give most of our time to one group or treat all equally? Is one specialized industry so deserving on account of the fact that it

may have a rather imposing organization or produce somewhat higher returns from its acreage? Does it present problems of comparative easy solution which give such outstanding comparisons that it should be given preferential treatment?

In my opinion, a division of activities on a crop preference basis is neither advisable or justifiable. Fundamentally, the need of the agricultural industry as a whole should be the criterion although extraneous considerations may dictate a choice. The selection of the more important farm insect problems ought to be the chief consideration, and these should be arranged in a scheme of operations so that the program is progressive and at the same time properly balanced.

Obtaining insect control data:—Theoretically the extension specialist is expected to pass on to farmers only the results of research and preferably those of his own institution. In this way a state-wide proving ground is established to test out practices which may or may not have been studied thoroughly.

Should the extension entomologist be obliged to confine himself to such a program? In my opinion, no. The farmer's attention is attracted to so much vague information and to so many ill-advised recommendations that the extension entomologist must be able to meet these situations with the correct facts whether they originate as a result of research or are based on other inquiries.

Research provides us with much of the information and perhaps 75 per cent of what we use. The most of this is sound and understandable. But what about the other 25 per cent? These researches may be available in some form or other but they may include information that has been so stated that it is not immediately usable.

This latter condition most often concerns minor operations in so far as the projects are concerned but in the minds of our constituents it may assume a magnitude out of all proportion to its actual value. Nevertheless, the specialist must be informed and that information cannot be faulty. Is it to be required of the extension worker that he spend hours or days or even weeks delving into a mass of literature only to discover in the end that his time has been entirely wasted?

Then we may spend weary hours poring over publications concerning investigations the results of which we recognize are sound, only to find that the conditions surrounding the experiments have not been stated clearly. These bulletins go to farmers who read them and not understanding the methods try to put the suggestions into practice. Failures often result and these discredit the control practice so thoroughly that the extension entomologist often is unable to overcome this opposition.

I recognize that I have not been entirely blameless in this respect. The thought has come to me that in publications meant for layman reading, the statements should be clear, concise, and devoid of phrases often used as a safeguard to the writer. Moreover, all the conditions relative to the successful termination of the experiment should be stated.

The correct evaluation of research findings:—The extension specialist must be sure of his ground before proposing a remedy. He must know the facts and have assurance that there are no pitfalls. One slip may be condoned by the layman. A succession of errors in judgment are fatal.

From a number of unsatisfactory experiences we are agreed that on account of the wide differences in conditions within our state we are compelled to evaluate for ourselves the results of research without regard to the political subdivision where these figures are obtained.

The development of a program:—The planning of a program of activities is not at all easy. Under our scheme of operations the entomologist is expected to plan the program in the several counties. Program planning needs to consider two essentials (1) short time work and (2) long time activities.

As an illustration of the short time project, the peach tree borer is a typical example. In this work 187 demonstrations were conducted over a period of four years in a total of 56 counties. During this period there were more than 986,000 trees treated. By this time in the more extensive peach orchards growers had adopted the practice and most of the orchardists having smaller acreages were treating their trees. There was no further reason for continuing the work and it gave way to some other project.

The long time project is one where there is not only a satisfying of immediate needs but future developments must not be overlooked. Take, for example, the apple orchard work. In the original program it was planned to take care of individual insect problems and demonstrate in addition the connection between individual and collective efforts, and the value of thorough and timely applications. With this idea fully developed the next stage or advanced project was commenced, at first in a small way and later in a larger fashion. Spraying information is a later name given to this idea. From this has developed the complete orchard spraying program. So that now we are stressing program in these areas and illustrating wherein the program is the most highly successful operation. The development of this project has covered a 15-year period and will continue indefinitely.

The completion of any part of the program is often determined by passing events as well as the success that has been attained through its

use. Some three years ago we thought that we recognized a condition of unrest approaching and that there was a definite reaction against service operations. The people aroused were not those who were following our suggestions closely, but were those men who were equipped to care for their extensive operations and whose methods were faulty. Sensing the trend of fruit growers opinion we are again prepared to meet the situation which appears to confront us. After analyzing the reasons for both failures and successes that occurred as a direct result of the insect suppression methods of presentation used, we are about to suggest a realignment of the methods so as to more nearly meet what appear to be the future requirements.

A major project may include work that is of state-wide importance or may, like the Japanese beetle, be of local import only, although it may have a bearing on its probable use over a larger area. Usually the difference is in the time which has to be allotted to the work as well as its extent on a regional basis.

The project of minor import is one usually run along with the major operation at the outset but is allotted more time later in the season. It is preferably given a tryout in view of the probable destructiveness of the insect in later years.

In ascertaining the problems and fitting them into the scheme of operations puzzling situations often arise. Where at all practicable, the field work should continue throughout the entire year, one project following another in order so that the year's activities will show a well balanced program.

Project organization:—The developing of an insect control project is by no means an easy matter. In order to do a piece of work and put it across with proper emphasis detailed planning is needed. The putting on of a demonstration is not the aim sought; that is but a necessary procedure. The people interested must play an important part in the operations if lasting benefit is to result.

As an outstanding example of project organization let us consider for a moment our Japanese Beetle Community Protection demonstration.

There were a number of factors concerned in the project, and in order to keep these clear in the minds of the community leaders a plan of organization was devised and suggested for their use. The accompanying diagram indicates the relation of the local leaders to the official workers and the means of approach to each group.

Other projects may not be arranged diagrammatically, but are specific in the written statements of the factors concerned.

Summarizing project results:—The collection of data from a demonstration is not for the purpose of ascertaining something new but to get information that will show to the average person something more tangible than casual observation permits. These may be in the form of a statistical summary in detail or they may be tabulated using only

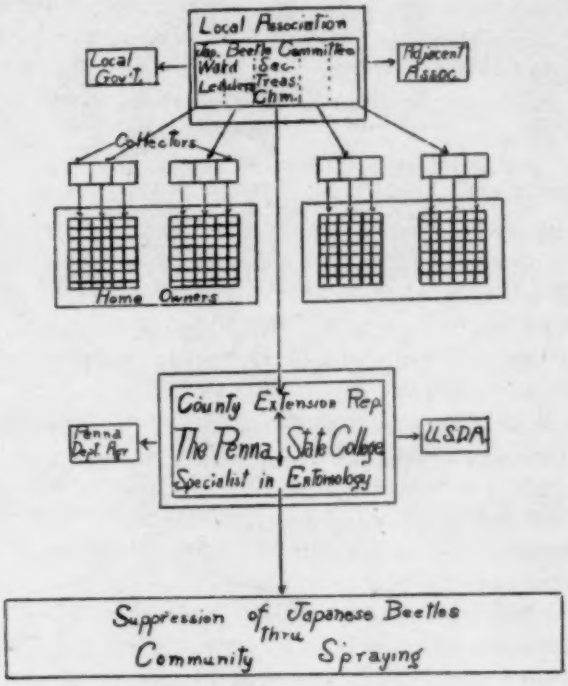

FIG. 69.—Diagram of Japanese beetle project

the more outstanding features as the captions. The use of negative results as well as positive often clarifies vague situations and these serve to eliminate adverse criticism by the inference that the cards are all on the table face up. The data used should be exact and any questionable figures should be discarded. Make the summation clear, concise, and do not attempt involved interpretations.

THE EVALUATION OF RESULTS.—There are two methods that may be employed: (1) the superficial method; (2) what may be termed the research method.

The superficial method may be disregarded as it is of no value, although sometimes used by inexperienced observers. The experimental

method is an adaptation of the research practice to data collection and is a basis for the true evaluation of results. These data then can be arranged in terms that are understandable to the layman and used to point out more clearly to him the value of a piece of work. For instance, in our beekeeping work the results from the use of improved practices during the first five-year period were summarized, Table 1, to focus attention to the value of their adoption.

TABLE 1. WINTER LOSSES OF BEES IN PENNSYLVANIA 1927–1931

Year	Value of colonies	Winter losses		Savings from practices
		Average	Improved practices	
	Doll.	P. Ct.	P. Ct.	Doll.
1927	1,112,000	34	6	311,360
1928	1,360,000	12	2	136,000
1929	1,415,000	15	5	141,500
1930	1,291,500	12	4	103,320
1931	1,164,000	21	4	197,880

The proper evaluation of the results of extension work:—This factor is important since we must always be on the alert lest we become swamped in a mess of petty detail. Accomplishment is not determined by a multitude of applause and good fellowship. In extension it is based solely on the change in insect control practices due to extension efforts. In the final analysis it answers the question of the why of extension work.

Figures collected by our administrative office each year indicate that between 1919 and 1931 as a result of 7,570 demonstrations and 5,732 meetings, there were 240,848 direct requests for specific assistance from farmers on insect control and beekeeping. In addition the estimated number of entomological practices adopted was 341,732. In 1933 the practices adopted were 1,977 more than in any of the other 14 lines of work represented in the Division of Extension.

The illustration is used only to direct attention to the thesis. The objective is emphasized to show that it can be attained.

METHODS OF CONDUCTING EXTENSION WORK

By C. R. CROSBY, *Ithaca, N. Y.*

In New York we have Farm Bureaus in 51 counties each with one or more agents. These men are all well trained and are, with few exceptions, of more than average ability for this line of work. Some of them have been in the work for many years and have become in reality specialists in subject matter if not subject matter specialists. This situation is in large part due to the policy of decentralization of responsibility for the conduct of the spray service and related activities consistently followed since the bureaus were established. These facts must be kept in mind if one is to understand our methods of conducting the work.

In New York we have two experiment stations, and a number of other agencies working on insect disease problems or on different phases of the same problem. Many of the results from these investigations are of immediate value to the grower and must be utilized without waiting for formal publication in research bulletins. The research workers in New York have always cooperated to the fullest extent in making the results of their experiments immediately available to the extension workers and through them to the growers.

The extension entomologist is first of all interested in having an adequate and effective spray service program functioning in each county. The term spray service is here used to include not only the spraying of orchards, potatoes and vegetables but also other related insects and disease control problems. The methods of conducting the spray service in New York have been described many times and there is no need to repeat it here. In the case of a new man taking up the work in a county, the extension entomologist may help him to plan the work and get it started but with the almost total lack of turn-over in the personnel of county agents in the past four years little assistance of this kind has been needed. The most important thing at present is to keep the agent fully supplied with subject matter in usable form. This need is met in two ways, conferences and summary bulletins.

Late in the fall before the winter meetings begin a state-wide conference of extension workers and investigators is held. At this conference the results of the year's experiments are reported and any changes in practices are discussed. The program is arranged by subjects and the investigators are not allowed to present formal papers. One control problem is brought up after another and each is discussed until all the new information is before the group and a decision has been reached as to what changes, if any, shall be made in the recommendations. Some

of the more important proceedings of these conferences are mimeographed but most of the information is left to appear in the series of extension bulletins to be discussed later. In addition to this general state-wide conference in the fall usually one or two regional conferences are held in the spring and early summer to anticipate difficulties likely to arise.

With the increasing complexity of the recommendations for insect and disease control, coincident with our increased knowledge of the problems involved, it has been found extremely valuable to publish summary bulletins for the guidance of our growers and the agricultural county agents. Formerly we used to issue such a bulletin and it was good till it ran out several years later. Recently, however, our problems and the ways of meeting them have been shifting too rapidly for this system to be satisfactory. For a number of years we issued spraying schedules for the different fruits each on a single sheet. These have been abandoned because the schedule has become too complicated for such treatment. We now put all this information into summary bulletins. In these bulletins just enough of the insect's life history is given for a background, but the methods of control are fully discussed with all the variations of the schedule necessary to meet the requirements of the different localities, different varieties and a varying climate. These bulletins are issued in small editions so that they will be used up within the year. They are revised each fall after the experimental results of the season are available and always after personal consultation with the investigator who has worked on each problem. So far we have published in this series bulletins as follows:

Fruit, 4 revisions.
Vegetables, 3 revisions.
Potatoes, 2 revisions.
Small fruits, now in press.

Furthermore, in the case of vegetables and potatoes it has been found necessary to issue separate editions for Long Island and up-state. In addition to these bulletins we issue each Monday from April to August, News Letters. These are largely summaries of the weekly reports of the county agents themselves but often serve to carry information of immediate value concerning methods of control.

These methods have been worked out in New York not because we planned it, but because it seemed to work out best that way.

EXTENSION ACTIVITIES IN THE ENTOMOLOGICAL PROGRAM FOR DELAWARE

By L. A. STEARNS, *Entomologist, University of Delaware, Newark, Delaware*

At times, such as this, when the programs of our sectional and national meetings may seem unduly burdened with papers relating to the high prevalence and ineffective control of some insect—for example, the Codling Moth—and when those of us who are wholly or in part responsible for Spray Service in our respective states are continually confronted with disturbing questions pertaining to arsenicals, arsenical substitutes and spray residues on harvested fruit, it is, in a sense, comforting to recall that the perplexity of today, in this respect, is but the problem of yesterday, slightly altered and intensified.

In the First Annual Report of the Agricultural Experiment Station of the University of Delaware, for the fiscal year ending June 30, 1888, which covered, in fact, but a period of three months, the Station having been organized on May 8 of that year under the Hatch Act, the following statement occurs: "The damage caused by the ravages of insects to various crops throughout the State is so great that the necessity for work in the line of economic entomology is fully recognized as being of the utmost importance." The control of Codling Moth was apparently of no less concern at that time than it is today. The first paragraphs of the report for the ensuing year (1899) deal with the results of experimental spraying for control of this insect with London purple. The final conclusion drawn—"that worm-eaten apples should henceforth be regarded as a sign of slack and careless management"—is especially significant in view of the recent, renewed emphasis upon effective spraying procedure and efficient orchard management in Codling Moth control.

Forty-five years have now elapsed since the establishment of the Delaware Station. Entomological problems, in the State, have increased both in number and complexity. During this period, the entomological program, which was, for some years, a combination of both research and extension, has suffered from frequent changes in its direction and from a lack of continuity. From 1889 to 1899, the work in Entomology and Horticulture was combined under one head, M. H. Beckwith, 1889–1896 and G. Harold Powell, 1897–1899. In 1900, these activities became separated, for the time being, with the appointment of E. Dwight Sanderson as Entomologist (1900–1902) and C. O. Houghton (1903–1908). From that year (1908) until 1925, limitation of funds prevented the continuance of such work, the responsibilities in this connection again being largely assumed by the Horticulturist. The provisions of the Purnell

Bill permitted, once more, the initiation of entomological research, in 1925, (H. L. Dozier, 1925–29 and L. A. Stearns, 1929–to date) and the passage of the Capper-Ketcham Act, in 1928, provided the necessary funds for limited extension activities in Entomology, during 1929 and subsequent years.

PRESENT ORGANIZATION AND FINANCING OF RESEARCH AND EXTENSION.—During the interval from 1908 to 1925, a period characterized, as mentioned above, by the almost complete absence of constructive effort in the field of insect control, in Delaware, notable changes had occurred, however, in the development of its agricultural resources. In particular, there had been a large increase in the acreage devoted to the growing of various fruits and vegetables. Intensive planting of those areas in the State, best adapted for the production of such crops, served immediately to aggravate infestation and to complicate the control problem. At the same time, both insecticides and the equipment for applying insecticides had been subject to equally important modifications.

With the renewal of investigational work, in 1925, the influence of the horticultural interests was sufficiently great, therefore, to result in the initiation of five projects, all relating to the bionomics and control of fruit insects—the Codling Moth, Plum Curculio, Oriental Fruit Moth, Grape-Berry Moth and Grape Leaf-Hopper. Although certain of these projects have since been revised, research up to the present time has been confined to the insects mentioned. Again, when limited funds became available first, in 1929, for extension activities in Entomology, it was necessary to utilize the part-time services of the Entomologist and Assistant Entomologist on the staff of the Agricultural Experiment Station in this connection. Such an arrangement has resulted in the continuance of a close coordination between the programs for extension and research. Spray Service for fruit crop protection has been, therefore, the extension activity of primary importance to date.

From casual consideration of what has just been said, it might seem that the present entomological program for Delaware is unbalanced from the standpoints of both research and extension. Further weight might be given such an impression by mention of the facts that, in total acreage, apples, peaches and grapes rank fifth, eleventh and twentieth, respectively, among all agricultural crops in the State and sixth, ninth and fourteenth, respectively, in total value. At the time, however, that the entomological program under discussion was instituted, the five fruit insects mentioned were unquestionably outstanding economic pests. Of even more importance, is the fact that there was an organized demand for investigations directed toward their more effective control.

In certain respects, all of these projects have already passed from the research to the extension phase. The knowledge that such service is now available in the case of fruit insects has resulted, especially during the past two years, in greatly increased demands for assistance and for instruction, which should result in a more general adoption of and adherence to approved methods of control for important pests of other crops. This fact is emphasized by the gradual shift in the amounts of the funds allocated for research and extension work in Entomology from a ratio of 8 to 1, in 1929–30, to 5 to 1, in 1933–34. Further expansion in this direction will be impossible under existing conditions in respect to personnel and funds. Confronted, moreover, with the probable necessity of curtailing expenditures, present indications are that there will be a need, more urgent now than ever before, of spending most wisely our few extension dollars, if all requests for such service are to be complied with.

Spray Service.—Spray Service for fruit crop protection, already mentioned as the extension activity of primary importance, has become, with the passing of each year, an increasingly difficult and, at times, a most perplexing responsibility. The normal requirement of modifying the annually published spray programs, during the growing season, to compensate for the usual seasonal variations in weather, in apple, peach and grape development and in insect prevalence is now complicated by the depressed condition of the fruit-growing industry and by the changing and stringent regulations concerning spray residue. The program for Codling Moth control, for example, must be acceptable, at the same time, from the standpoints of the existing infestation, the more exacting requirements as to spray residue on harvested fruit, insecticidal efficiency and the financial capacity of the grower.

The methods of procedure in the conduct of this project have been essentially the same each year, for an endeavor is being made to build up a series of comparable seasonal records. Observations relating to host development are made periodically thruout the growing season in representative orchards and vineyards in each of the three Delaware counties. Daily emergence of the spring brood of the Oriental Fruit Moth and Codling Moth, in hibernation cages located at five different points in the State, is recorded thru the cooperation of interested orchardists. These data are supplemented by records of the complete seasonal emergence of both insects obtained thru bait pans. Jarring collections of adult Curculio in the case of peaches and larval collections of Codling Moth from banded apple trees are made weekly. Records of periodical counts in respect to twig infestation by the Oriental Fruit Moth, of varying abundance of

the Grape Leaf-Hopper and of progressive infestation by the Grape-Berry Moth are likewise secured for the entire season. The information, thus obtained, is transmitted thru the "Orchard Spray Notes" to the fruit growers of the State. This medium for broadcasting is supplemented by the daily posting of certain data on bulletin boards, centrally located in each of the two, more-important, fruit-producing counties.

SPRAYING DEMONSTRATIONS.—Each year, in connection with experimental spraying of apple, peach and grape, plots are included to test and to demonstrate as well the efficiency of the recommended spray programs for combating the major pests of these important fruit crops. The plots in question are located in different orchards and vineyards from year to year, in order that new contacts may be made with the growers and to determine the efficiency of the several programs under varying conditions of infestation, spraying facilities and orchard and vineyard management.

SUPPLEMENTARY MEASURES FOR CODLING MOTH CONTROL.—In Delaware, as in other states, the Codling Moth control situation has been a most critical one, during the past four years. The population of this insect, produced under the climatic conditions prevailing during the growing season of 1930, became so tremendous that in certain areas the apple spray program proved totally inadequate. Orchardists, in the districts primarily affected, were immediately urged to adopt all known and approved supplementary control measures. This endeavor received continued emphasis, during 1931, 1932 and 1933, thru meetings, circular letters, correspondence and personal visits to individual growers. Concerted effort, in this direction, has already effected a substantial reduction in the high level of Codling Moth infestation, which prevailed rather generally thruout Kent and Sussex Counties subsequent to the drought of 1930. During 1933, infestation showed a marked increase, however, in certain orchards, where either spraying had already ceased or ineffective arsenical substitutes were being employed due to uncertainty in the matter of residue requirements and to a desire to avoid the necessity of installing expensive washing equipment. It is evident, therefore, that this project must be pushed with undiminished vigor in the year ahead.

SUPPLEMENTARY MEASURES FOR CONTROL OF PLUM CURCULIO ON PEACH.—In 1932, a campaign was initiated to induce peach growers of Sussex County, the two-brooded area of the State, to adopt supplementary measures for the reduction of Curculio population in orchards where spraying alone had not given adequate control. This project received increased attention during 1933.

Special emphasis was placed upon the practice of picking up peach drops infested with first brood grubs, during late May and early June. This measure was quite generally adopted thruout the County mentioned, in 1933. There is every indication that peach growers are now inclined to look upon it with considerable favor as an inexpensive and, at the same time, effective insurance against pre-harvest, second brood infestation and also as an important method of reducing the wintering population, of this insect.

Apple Maggot Survey.—The discovery of Apple Maggot in the maturing crops of unsprayed early apples in the vicinity of Wyoming in Kent County, during 1932, constituted the first authentic record of its occurrence in Delaware.

A preliminary survey of the situation was made, in 1933, which included the recording of spring emergence of adults and the determination of the approximate area of distribution.

The resulting emergence data and the almost complete absence of this insect in well-sprayed orchards emphasizes the fact that the applications of the present spray program are well adapted for Apple Maggot control. Distribution is now confined to a small, well-defined, elongated area of continuous infestation, wherein eradication could undoubtedly be effected by recourse to known methods of control. It is an extension project worthy of immediate and serious consideration.

Mosquito Control.—Realizing, at last, that the elimination of the Mosquito is necessary to permit greater agricultural and resort development and to provide better for the year-round comfort of Delawareans, an organized effort has been directed toward that goal, during the past two years. The aid of the Department of Entomology was immediately sought in this connection.

In 1932, a survey project was instituted to investigate the character and extent of the mosquito problem in Delaware and to determine the necessary measures for relief from this annoyance. During 1933, as a logical step, subsequent to this survey, an endeavor has been made to instruct the people of the State concerning the essential facts of local, mosquito biology, to acquaint them with the breeding areas and conditions responsible for mosquito prevalence and to direct their thought toward effective procedure for elimination of the mosquito nuisance.

The results of the 1932 survey indicated conclusively that freedom from mosquito annoyance thruout a greater part of the State will depend largely upon the control of the Salt Marsh Group of Mosquitoes thru the elimination of the extensive areas in which they are bred, by large scale operations, including ditching, diking, hydraulic fill, flooding, et

cetera. The first, notable step in this direction was the allocation of two Civilian Conservation Corps units to Delaware for such work, during the six-month period, October 15, 1933 to April 15, 1934, with a possibility of continuance during the subsequent six months.

The Department will undoubtedly be required to play an important part in the future of the mosquito control movement by assuming certain research obligations, in its partial responsibility for the necessary educational program and in an advisory capacity in the mapping out of effective control procedure.

Boys' and Girls' Club Work in Entomology.—This project, comprising insect identification and control, was introduced first, in 1933. As originally planned, it was to be conducted in conjunction with the existing, Home Vegetable Garden Project in New Castle County. Eventually, it included, as well, an instructional program in Entomology during the annual 4-H Club Short Course, and the judging of insect collections by club members exhibited at the Kent-Sussex Fair.

The need of this project was apparent in the fact that the average boy or girl has little or no conception of practical insect identification and control. It was believed that such information, if properly presented, should prove of benefit to both club members and their parents.

Present indications are that there will be a greatly increased demand for such work, during 1934.

Coordination of Research and Extension.—In September, 1933, there appeared, in mimeographed form, a comprehensive and most interesting report by T. Roy Reid and M. C. Wilson dealing with the "Functions and Activities of State Extension Specialists."[1] Data included in Table 24 (page 35) of this publication, an "Evaluation of Qualifications of Agricultural Specialists" (493 specialists and 42 extension directors reporting), indicate that approximately one-third consider experience in research work as unimportant and less than ten per cent designate it as essential.

The desirability of previous research experience as a qualification of the extension specialist and the question of the advantages and disadvantages of close coordination in research and extension activities have long been controversial subjects. In such a matter, it is impossible to generalize. Specific conditions, especially in respect to organization, must be the deciding factor.

Delaware is a small state of but three counties. Its agriculture is

[1]Extension Service Circular 189, Office of Cooperative Extension Work, U. S. Dept. Agri., Wash., D. C.

marked by its diversity and intensity. The field for research and extension work is always close at hand. At present, but 16.8 per cent of the total extension funds available is expended in specialist activities and, furthermore, slightly less than 10 per cent of this amount, for Extension Entomology. Specialists are directly responsible to the Extension Director. Although the program of a specialist in any given county is supposed to represent a portion of the extension program for that county, it is in large measure determined by specific, subject-matter needs and requires but little cooperative effort on the part of the County Agents. Experience, during the past four years, indicates clearly that, under local conditions and with limited funds, the present close coordination of research and extension activities in the entomological program for Delaware is essential for most effective results.

AIMS AND PURPOSES OF EXTENSION WORK IN ENTOMOLOGY

By A. B. GRAHAM, *Washington, D. C.*

Of course one of our great aims and important purposes is to acquire from research groups accurate information and adapt it to public use that it may be generally applied. This part of it I think is quite generally accepted without further discussion; our particular aim is to reach the great body of tax payers and voters who, after all, control the purse strings and according to their state of mind, permit us to expand or limit our activities.

Our purpose is to make known general control methods, whether it be directly through the extension organization or indirectly through industry and trade. In order to accomplish such ends it is found necessary not only to study the habits or behavior of insect life, which is of course essential for all entomologists, whether extension or research, but the extension worker must make it his business to study the behavior of man because he is the one who must be brought to a full realization of the necessity for meeting the inroads made by insects on his precincts.

Appeals of various kinds must be made to him, not once but repeatedly until he finds himself impelled to seek or to accept the teachings exemplified or advocated by the extension worker. These appeals may be classified under such headings as economic, self preservation (food supply), and probably egoistic and altruistic.

There are three major avenues to one's mind—the eye, the ear, and the hand. Each individual probably has one of these characteristics domi-

nant; one must prepare instructional material to reach the individual by each of these routes, but particularly by the one or through the one he receives best. Every teaching means, such as the oral lecture (ear), news item (eye), circular letter (eye), demonstration (hand, eye, ear), slogan (eye, ear), and perhaps some plan for participation (hand), in which the hand or the whole body takes part, should be used.

Probably 60% of all groups of people are so weak in the constructive powers of their imagination that object lessons, such as are given through demonstrations, must be resorted to. Another 20% may receive the lecture; may read a non-illustrated bulletin, a news item, or a circular letter and get the idea, but we dare not confine our teaching to this select group who do what we desire them to do from mere telling.

In addition there no doubt is another 20% for whom it is very difficult to receive lessons by any means through which information may be transmitted. In such cases we must depend upon examples set by those who are worthy of imitation, that this group may without much understanding follow them because they are worthy of imitation. Our purpose ideally, if not practically, should be to reach all of them in some way.

As to the possibilities of extension work with young people we should consider the expectancy of life. A boy or girl of 14 years of age has a chance to live 46 years. Information concerning insect control at this age has a long period of time for its application. If our insect control work is to be confined to those of advanced years, say 45, there is only an expectancy of 25 years within which to use it. Much of that period would probably be put in in retirement. It pays to begin early if it goes no further than insect identification and insect control in orchard or other fruit growing clubs.

Since it takes the greater part of a generation to establish generally some worthwhile practices, the earlier we begin on the job the more general and permanent the practice which is likely to be adopted. We must keep in mind that mere information-shoveling does not provoke or prompt people to act. There must be some drive or impulse, desire or instinct to do before information becomes of any practical use. Let us look well to the behavior of men that they may have dominion over insects as well as over the earth.

POPULARIZING ENTOMOLOGY

By Bristow Adams, *Cornell University*

In talking about popularizing entomology, I am assuming that most of this audience agrees that entomology needs to be popularized. I, personally am convinced of it, and feel that this point need not be argued. But for the sake of those who are impatient of this idea of popularization, it may be said that a current situation in government and finance, and in the temper of the people, demands that the people shall know what they are paying for; and most of the entomologists in the United States are supported by, and directly answerable to the tax payers. The entomologists are not alone in this situation; their position is shared by most of the workers in the natural sciences.

Dependent upon public favor as we are—and we are dependent, regardless of whether we are willing to admit it—the public must have knowledge of what entomologists are doing if it is to support the science,—if it is to hold up our hands to the good work we are doing.

A few years ago, Dr. Wilder Bancroft, chemist of Cornell University, made the principal speech at the dedication of the science hall at the University of Southern California. The title of his talk was "How to Ripen Time," and that title was mystifying until he gave examples of men like Galileo, Savonarola, of LaVoisier, the great French Chemist, whose discoveries were not accepted until centuries later, because when they lived "the time was not yet ripe for them."

LaVoisier, you will remember, was held to be an aristocrat by the Paris mob at the time of the French Revolution. Revolutions meant nothing to him. He was at work in his laboratory when the mob broke in to drag him to the guillotine. He did not plead for his life, he asked merely for time to complete the important experiment on which he was then working. But what was a chemistry experiment to an ignorant public?—The time was not ripe. And the science of chemistry was set back a hundred years.

We have a parallel today, not literally the same situation, but figuratively the same, with the public, through its representatives, telling the scientist that his official head is cut off through lack of appropriations, his work is stopped or curtailed and crippled, the public—the great unthinking and unknowing public—suffers without realizing it, and scientific progress is set back.

Not alone is the general public—or the ignorant public, as it is called—intolerant of things which it does not understand, but so is the scientist.

Who does not remember the ridicule which followed the plunge of Langley's air-drome into the waters of the Potomac, and the solemn pronouncement of no less a person than Simon Newcomb that the idea of air navigation by a heavier-than-air machine was a chimera, a figment of the cracked brain—like perpetual motion. And he proved it—mathematically. And then the Wright Brothers proved him wrong—mechanically. And now we know that the Langley Machine would have flown had it been properly engined and properly launched.

Each science, therefore, must translate itself, interpret itself, not only to the general public, but to the rest of the scientific world.

I recognize, of course, the natural desire of the scientist to be let alone to pursue the truth as he sees it, without interference from the outside world, and without any loss of time to explain what he is trying to do. I sympathize with his attitude for I have often rebelled at the necessity of attending conferences and writing reports when I have felt sure I would rather have the time for productive work. It is this feeling which makes an entomologist desire to emulate the trap-door spider, to retire to his hole, and to pull the hole in after him.

Two main reasons must actuate us however, in popularizing entomology. As I have already hinted, most entomological work is done in public institutions—the United States Department of Agriculture, State Departments of Agriculture, National and State museums, and particularly in the Land Grant Colleges and Experiment Stations.

So first, we owe an account of our stewardship to the public which entrusts its funds to our use. Secondly, we must assure the public of the value of our work if we maintain its confidence.

Oh, I know we write annual reports, but who reads them? In New York, the annual report of the Experiment Stations is printed in an edition of 3,800 copies. How far does that go in a population of 12 millions? One copy goes to the desk of each legislator—senator and assemblyman—on the day the legislature convenes, along with the reports of other state institutions—jails, insane asylums, almshouses, and the rest—and the pages and janitors remove them. That is one sure way that all the recommendations are "carried out."

But if we popularize entomology in readable bulletins, in books, in magazines, and particularly in newspapers, the one printed medium which everybody reads—the voice of the public reaches the legislator in a language which he understands and heeds.

I do not want to make this appeal for popularization of our work on a basis of mere self-interest, for the work of the true scientist has lit-

tle value to him unless it has real value to humanity. His trusteeship really represents a fine sense of public duty and of public conscience.

Yet the appeal on the basis that if entomologists wish to carry on, they must let the people know, is a valid one. We have seen the efforts of the Director of the Budget, to do away with continuing appropriations, such as those provided for in the Hatch and Adams, Morrill and Purnell, Capper-Ketcham and Smith-Lever Acts, and we know that the Land-Grant Colleges and Experiment Stations could not plan long-time experiments and research projects without the assurance given by this government support. This is a problem that actively and seriously confronts the Association of Land-Grant Colleges and, indeed every scientific organization in the country.

Entomology needs to court public knowledge, public sympathy and public support more than most others, because it must overcome an ingrained public prejudice shared by no other science, except perhaps, that of herpetology. To put it into the vernacular "people just naturally don't like bugs." That sentence epitomizes their attitude and their lack of knowledge. Of insects beneficial to man they are grossly ignorant. In any group of "the-man-on-the-street" and his confréres, asked to name insects beneficial to man, several might hazard the honeybee, and one or two may think of the silk-worm—though the vogue of rayon has tended to remove the silk-worm from the picture.

Of the insect menace they have a more direct knowledge; moths destroy clothes, weevils ruin grain, termites demolish buildings, borers ravage lumber, mosquitoes murder sheep, spiders sully ceilings, and flies infect food. They're a bad lot. We don't like 'em.

Much has been done toward popularization. The work of the Comstocks, John Henry and Anna Botsford, under whom, with Vernon Kellogg, I first learned my entomology, has accomplished much. Maeterlinck's life of the bee, fanciful and poetic as it is, has been a help. The writings of Henri Fabre have done wonders though to a limited audience. The more recent books of Leland O. Howard, especially "The Insect Menace" have been eye-openers to many.

But books really reach a limited audience. Twenty-thousand copies represents a large circulation in the book world. The daily circulation of the New York Times is about 70 times as great; of the Hearst newspapers 450 times as great. You may smile at the mention of the Hearst newspapers, with their weird pseudo-science, yet it was the Hearst newspapers which really introduced Henri Fabre to a general reading public.

Let me recall to your minds that the words engraved in gold over the arched entrance to the children's room in the Smithsonian Institution in Washington are these: "Knowledge Begins in Wonder." And let me add the further quotation that, "Men are but Children of a larger growth,"—and of not a greatly larger mental growth, for the educators and psychologists tell us that the average, or typical, adult mentality is somewhere in the neighborhood of that attained at from eleven to fourteen years of age. And these are the people we must reach if we are to convince the public of the validity of our services to mankind, and of our claims to their consideration through their chosen representatives from whom we receive the appropriations by which we are enabled to carry on.

This, then, is the basis of my plea for you gentlemen to share your knowledge with those who may interpret it to the public—These interpreters may be reporters, none too skilled in presenting science; they may be the agricultural editors in your institutions. They may get you wrong; they may misinterpret, they may sensationalize. You must keep in mind that they have to speak a language which the public understands. From long experience they know that it is impossible to over-estimate the ignorance of that public. But you can take comfort from the fact that you can not over-estimate the intelligence of the public in coming to sane and right conclusions once it knows the facts, once the veil of ignorance is lifted. And bad as a reporter may be, he can not really do you any harm. Keep in mind the old adage "Better be damned than not mentioned at all," and remember that Cornell University made its greatest gain in number of students at the time when it was most prominently in the public prints because of a deadly typhoid epidemic about thirty odd years ago.

I do not ask you to take my word for this, you have better evidence than that. It was my good fortune to listen to Walter Hines Page, late Ambassador to the Court of St. James, when he spoke to the bureau chiefs of the Federal Department of Agriculture, just before he left for his post in England, and just after he had relinquished the editorship of the "World's Work", and his important position with the Doubleday-Page Company. As far as I know, what he said there has never been published; and he said some pungent things. You may not agree with them. With some of them, I am not myself in entire agreement, especially in his statements that because a man is a scientist he has a finished incapacity to express himself in writing. But let us have his spirit speak for itself. I quote:

"You must", he said, "get your information out to the public. I cannot begin better by saying this: I have been trying for ten years to get an article for the World's Work about the Agricultural Department. I regard it as the greatest educational institution in the world that I know anything about. I have had at least ten articles, some by you gentlemen yourselves, some by gentlemen who make magazine writing their business, and some by gentlemen with great names. Here is a big subject, there is a big man; put the two together and you generally get nonsense. There's nothing wonderful about that. Let me assure you that I have the greatest respect for you as gentlemen of science. In common with the rest of the intelligent world,—I have respect for your work. I have more than that, I should like to express my thanks for it. The whole United States feels thankful to you. That is one proposition.

"As to the next: For you to say that because a man is a great scientific explorer, or master of research, he can tell the story of what he has done, is a mistake. Ninety-nine cases out of a hundred he can not do it. This is not prejudice on my part. It is the perfectly natural result of your work. You cannot speak the language of the people.

"For twenty years of my life I did not have the impudence to look a great man in the eye and tell him that, but it is a fact and there is no use concealing it. The probability is that the greater you and your work are from a scientific standpoint, the greater imbecile you are as a literary artist. You might just as well recognize that fact. You write to one another admirably in your lingo—and it is lingo. There is no literature in it; there are facts, of course, but it is just as much lingo as is the mathematical formulae of astronomers. That is the starting point.

"But most of the men engaged in the business of writing, come around and worry you. Few are well-trained and many of them do their work in a pretty slip-shod way; you are not willing to tell them things because they get them wrong and put you into all sorts of difficulties.

"To give knowledge to the people of the United States who are not scientific readers: You have two or three channels. One is bulletins. I have read many thousands. I recall very few that have moved me. These, of course, are not written by the chap who drops in and says: 'Doctor, what news have you got today?' jots down a few words and runs off. They should be written by a man who has made it his serious business to take a body of facts and write them in the common, simple words of the people, words they use when they make love, when they suffer sorrow, when they bury their dead—in the simple words of the whole people. You want to put your discoveries about insects that

destroy other insects in that simple language, and you will never reach the people until you do.

"The Iliad is nothing but the story of how one fellow stole another fellow's wife, and they had a fight about it that involved two nations. It is nothing but a yellow-journal story such as you can see in any morning paper, but it has lived all these years, not because the woman in the story is rated beautiful—the woman always is—not because the husband felt himself insulted and went to fight the other man—that is often the case in our time. It is because the man who told the story told it with supreme simplicity, and that is the only reason why you have been brought up on Homer, and it will live forever."

Then Dr. Page offers a good word for the news-editor of your institutions. He says: "He has the difficult feat of getting the information that you gentlemen have. He has got to know pretty thoroughly everything you do, and its bearings on life and its relations to work, and he has got to fix that in his mind as a real narrative of human interest.

"That goes out without cost and gets tremendous circulation. The papers want to serve you more than you want to get your information out. I assure you that I never saw a human being so hungry for anything in my life as a good newspaper man is for a good article, and he will thank you any day you will give him one, and love you if you do.

"Upon my word, sir, the press of this country wants to serve the American people as much as you gentlemen do, because the breath of its life is just that. If it does not serve the people, it dies. The only person in the world it is under contract to is the man who pays his three cents a day to get it—or three dollars a year for my magazine, and I have got to serve him. Now anybody who helps the editor to do that serves the editor, and the editors, everyone of them, want that help.

"The public is our master. If you carry to the public the information that you gentlemen have and are constantly finding in your researches, and can put it in—I won't say one syllable words, because it does not matter whether the words are long or short, just so they are plain—just into the thought of the public and in a form suited to its mental point of view—I don't want to say anything rash—but I should say without a moment's hesitation, that a new day would begin forthwith.

"A new day would begin too, in the usefulness of the publications, which is quite an important matter, and a whole lot of immature, erroneous miscellaneous, bad stuff that they publish would be thrown out, and its place would be taken by better.

"When we abuse the newspapers, and many of them deserve it, you must remember always that a good deal of wretched stuff they publish

is put in because they cannot get better; and if you can give them better, they would like to have it. But no matter how unworthy and mercenary they are, that is not your business. You should feed them. You can fill the whole press of the country from the poorest agricultural paper to the most energetic daily; the magazines are entirely at your service."

This ends my quotation from Dr. Walter Hines Page; it has been given at some length because it is specific and it is authoritative. I might add, as a bit of corroborative evidence, as to the willingness of the newspapers to use such news material, that the papers of New York State, in the month of November just past, printed items from the colleges of Agriculture and of Home Economics, and the Cornell University Agricultural Experiment Station, for a total circulation of 40,960,000. This figure is not a guess; it is based wholly on press clippings that actually came to my office.

Now let me descend to another level for my final point, which is that the flow of news about entomology, or any other branch of science, must be consistently and constantly continuous. A splash of news, no matter how interesting, followed by a period of silence is relatively ineffectual. It is an aphorism of advertisers, that advertising does not jerk, it pulls. Doubtless, you are familiar with the piece of doggerel:

The constant drop of water
  Wears away the hardest stone;
The constant gnaw of Touser
  Will get through the toughest bone;
The constant, cooing lover
  Carries off the blushing maid
And the constant advertiser
  Is the one that gets the trade.

There is enough to say, that is new or relatively unknown, to have something interesting every day.

In the field of advertising the classically tragic case is that of Day & Martin, Shoe Polish Manufacturers of London. They were world-famous literally. Wherever shoes were shined, there shone Day and Martin. Charles Dickens said Sam Weller polished the boots of Mr. Pickwick with Day and Martin's blacking. The literary pages of Carlyle, George Eliot, Thomas Hood, Bret Harte, and Kipling contain references and allusions to Day and Martin. But the company went out of business, because as the manager confessed, "We did not keep up our advertising."

And I don't want to see any entomologists go out of business because the public "did not keep up our appropriations."

Thus endeth at least a few of the things I would say about popularizing entomology. If I may summarize, I would say, in conclusion, that entomologists owe an accounting to the public; that we must "ripen time" to an acceptance of scientific discovery, and that the task is difficult. It may, perhaps, be done best by using the newspapers, the one form of print which everyone reads; be sure that the newspaper is eager to present the facts. And finally, we must realize that facts prevail only through constant reiteration.

PROCEDURES RESPONSIBLE FOR MINNESOTA'S SUCCESSFUL GRASSHOPPER CONTROL CAMPAIGN

By T. L. Aamodt, *Assistant State Entomologist, University Farm, St. Paul, Minnesota*

The important points to be cited in relation to the Minnesota grasshopper control campaign are:—the organization for the application of scientific methods used in control and the injection of business policies into entomology. It is probably well to emphasize the fact that the science of entomology, the methods entomologists have worked out for grasshopper control, no matter how efficient, mean little if the farmers are not properly organized and instructed as to the methods of using the materials prescribed by science. Cooperative effort is of extreme importance in a grasshopper control campaign. The necessity of injecting business into the work of insect control, therefore, is evident. The problems of obtaining financial aid, of getting the support of the business men, of the railroads, of officials in various branches of government over the state, of manufacturers of the various ingredients to be used in the immediate control are all business problems and essential for success. The business of bookkeeping is also a very important phase of an emergency control campaign of this kind. Dangerous difficulties sometimes arise unless there has been a proper tabulation of expenditures of shipments and of numerous other items. In order to purchase materials daily, as found necessary, fund balances must be constantly available. Our insect control campaigns in Minnesota have definitely proven that economic entomology and insect control should not be taught only as a pure entomological science. At least some courses in economic entomology and the control of insects should be taught from the standpoint of en-

tomology in relation to all of the various industries and activities which become so closely related to the control problems as a whole.

Egg Survey As Basis For Predicting Grasshopper Infestations. —There is nothing that will establish confidence in the organizer and among farmers to be organized for a campaign more quickly than a definite egg survey. It was found that it cost more, took more time and painstaking effort to effect a control campaign in a county where no egg survey had been made. Because of the lack of information on egg number the losses were usually heavier in unsurveyed counties because of delay. Nothing was more valuable in spurring the farmers on than to be able to point definitely to spots in their county and say that so many eggs were found there and so many there. Farmers in Minnesota now look upon an egg survey as the "real goods." In predicting the grasshopper outbreaks in Minnesota we make use of the following criteria:

1. Maps of each township, made by farmers and chairmen and supplemented by observations and opinions.
2. Maps of each county, prepared by the county leader or agent and including information from the townships with observations.
3. Amount of poison used and where used in each county the previous year.
4. A comparative study of the infestation maps of previous years.
5. A check-up of the facts disclosed by these studies through an extensive, thorough egg survey in each infested township and county in the area.

The egg survey was simply a check-up on the veracity of the maps turned in by the county leader or agent and his organization. In only an insignificantly few cases did the egg survey map differ from the one turned in by the county organization. It must be remembered that previous to the egg survey the counties had been thoroughly organized and educated to the methods necessary for control. It can be said, then, that units, well educated and thoroughly organized throughout the infested area, are the first requirements. To organize thoroughly takes very little more money than is usually expended for routine work by State Entomologists. The Minnesota grasshopper surveys were made in cooperation with the U. S. Bureau of Entomology. Grasshopper egg surveys should be a function of the federal government with the cooperation of the State Entomologist.

Examination of grasshopper eggs taken from the frozen soil at intervals through the winter indicated that eggs were 90 to 100 per cent viable. It was shown that winter conditions had little, if any, effect on their

vitality. With this definite information in mind we were in a position not merely to predict but to state definitely what was actually going to occur in Minnesota following this egg survey in 1931. It is the general opinion of the leading entomological authorities on this subject in the world that in spite of weather conditions, when eggs are once laid in the soil in extremely large numbers, a severe grasshopper outbreak is bound to occur in at least some areas.

PRELIMINARY ARRANGEMENTS FOR CONTROL CAMPAIGN.—When it was definitely established that we were to have a grasshopper outbreak, it was evident that the first move was to mobilize officials and agriculturists who naturally would have some connection with a control campaign. A "Grasshopper Control Campaign Committee" was formed. This committee was made up of the Minnesota Commissioner of Agriculture, the Director of Agriculture Extension and the State Entomologist. It was the work of this committee to outline cooperative policies for the various departments concerned. The State Entomologist, who directed the policies of the campaign, immediately appointed a trained man to supervise the work in the state. A chemist and other assistants were also appointed. Just as soon as the duties of the various branches of organization were outlined, every county in the state was surveyed to obtain information as to possible infestations not before known. The purpose of this was to avoid neglecting any county in which the officials and farmers wanted information or organization regardless of actual infestations.

All of the eighty-seven counties of the state were consulted regarding grasshoppers. It was not the intention to unduly alarm the farmers of Minnesota living in the grasshopper infested areas. The idea was merely to present the facts so that proper and timely control methods could be applied. It was realized that unless immediate steps were taken to organize the farmers in the infested areas and unless the proper control methods were used at the right time, we could expect one of the most serious agricultural situations the farmers in Minnesota had ever faced. It was felt that the money and time spent in organizing and preparing to control the grasshoppers was insignificant when compared with the possible loss if the expected outbreak were not checked in time.

CONFERENCE WITH COUNTY COMMISSIONERS.—The next important move was to approach the responsible officials and units in each infested county for the purpose of establishing a county organization with a capable man in charge. During the period that all of these functions were being performed, frequent explanatory circulars were being sent out to the infested areas. The natural course to follow was to secure the co-

operation and backing of the local officials in Minnesota, the county commissioners. This having been arranged, the next step was to appoint a county supervisor who would have the full support and backing of the county commissioners or officials. In many counties there was an agricultural agent or a farm bureau office already established, and in such counties the work was carried on through that office. The supervisor worked directly under and in cooperation with the state officials. Meetings and conferences were continued until a responsible man was appointed as supervisor in each of the fifty-five counties concerned. It was distinctly pointed out that no poison bran would be forthcoming unless one good man at least was appointed to supervise the work in the county and to organize the farmers properly. As soon as these supervisors were appointed they were thoroughly instructed by the state supervisor as to control methods and general procedures. The county supervisor or leader immediately began to outline the infested areas and to select individuals who would make good township leaders and leaders for bait-scattering crews. The appointment of such men was early enough in the season to give ample time for organization and preparation before grasshopper hatching. The actual organization work should start during the fall and winter months previous to the actual poisoning work.

Organization Within County by County Supervisor.—It was up to the county supervisor, after receiving his instructions, to organize the farmers in the infested areas. It was the duty of the county supervisor also to call meetings in any infested township in the county and in some infested counties such meetings were held in as many as fifty townships. These township meetings selected their own chairmen. The chairman was responsible for all the work in his township. After the township organization was set up the county supervisor presented the information necessary for effective grasshopper control. It was definitely pointed out that in the last few years, in many places where the numbers of grasshoppers were enormous and conditions seemed hopeless, well organized and well supervised campaigns, begun early in the season, gave nearly 100 per cent protection to crops. Campaigns completed before the grasshoppers obtained their wings always assured protection to crops. To wait in order to see what was going to happen; to depend upon individual efforts; to wait until the destruction of crops had begun and until the grasshoppers were moving from one farm to another, always resulted in disaster.

The State Entomologist and his men refused to carry on work in any county lacking the leadership of a man fully supported by the county

commissioners and officials. Satisfied that the organization as outlined had been properly set up the next step was to call county-wide meetings through the organized units. It was not at all difficult to call county-wide meetings with an organization perfected. It was easy to reach every single farmer in the infested areas by telephone with such a set-up. The men appointed to various divisions took considerable pride in their work and cooperated in every single instance. Definite schedules were made out for the state as a whole. County agents were notified several days in advance of meetings so that they could have adequate time to send out notices and advertisements including mention of the speaker provided from the Entomologist's office.

Some of these county-wide meetings were attended by as high as a thousand farmers. Meetings were held in courtrooms, town halls, high schools, creameries, barns, out-of-doors and in fields.

The purpose of the first series of county-wide meetings was to prepare the organizations and the farmers for the first phases of the campaign. The first lectures did not necessarily cover the matter of control. They dealt with problems of organization, cooperative action, the establishment of mixing stations and general questions. It might be said that the main purpose of the first series of meetings was to create confidence among the farmers in the procedures we were intending to follow. We knew that without the confidence of the farmers little could be accomplished. The farmers were given clearly to understand that no outside aid from specialists or material would be given to any units where good cooperative organization did not exist according to the outlined form.

Recruiting Important Organizations of the State.—Next we proceeded to the enlistment of the full support of leading business, businessmen's associations, millers and millers' organizations, railroads and railroad officials, and officials in firms connected with the manufacture of any of the ingredients to be used in grasshopper poison bait. Without the full support, the backing of the influential business leaders of the northwest, a campaign such as conducted in 1932 and 1933 in Minnesota would have been utterly impossible. It takes but one experience in an insect control campaign, in which large quantities of materials are to be used, to show the necessity of adequate transportation needs and the timely delivery of materials which must be purchased at a reasonable price.

Funds for Materials.—Another important step was to present the problem to those officials of the state of Minnesota who were responsi-

ble for making emergency appropriations. After the state had been well organized and every farmer in the infested areas was informed as to the grasshopper situation, certain sums of money were requested from the State Executive Council for the purpose of purchasing poison bran bait. The state officials were convinced of the necessity of making appropriations mainly because of the thorough organization which definitely proved the situation to be a serious one. With the backing of many thousands of organized farmers and practically all the businessmen's organizations of any consequence, there was no alternative for those responsible. The State Executive Council, which is responsible for making emergency appropriations in Minnesota, responded quickly in taking the responsibility of appropriating large necessary sums.

No state or unit of government can expect the responsible officials to appropriate money when the requests are based on practically nothing more than the opinion of a handful of unorganized individuals. If an organization responsible for insect control in any state is awake and on the job building up its organization early in the season and not waiting until the last minute when the actual crop damage is taking place, it is impossible for the officials to do anything but take the responsibility of granting funds for the work. When twenty thousand or more farmers in the state are clamoring for aid to save their crops from unforeseen and unavoidable loss, action, even to the extent of calling a special session of a legislature, seems justified.

It is the duty of an Entomologist and his staff to bring proof that funds are needed in emergency outbreaks of insects. It is not one bit easier to obtain financial appropriations in Minnesota than it is in any other state or unit of government in America. Those responsible for making appropriations require just as much proof, and possibly more, before an appropriation is allowed. The officials in Minnesota responsible for insect control did not wait until the last minute to request aid and for this reason it was unnecessary for Minnesota officials to refuse, saying that the laws of the state prevented or made it difficult to obtain appropriations for insect control. The Entomologist should have enough knowledge of the political structure of his government to know where and how to apply for help. He is hired by the people not only to study insects but to impress those responsible with the necessity for insect control.

Purchasing and Shipping Materials. — It was clearly pointed out to all the organizations in a county that the state appropriation would go for the purchase of materials and their transportation into the main shipping points of the county only. All local transportation, mixing

and spreading of the bait within a county was done by the organized units of the county and its townships.

The total of approximately five hundred carloads of dry grasshopper bait were distributed in fifty-five counties of the state of Minnesota in 1932 and approximately forty-five carloads were distributed in 1933. The bulk of material used in 1932 was shipped within a short period of about two weeks. In one particular instance it was necessary in one day to purchase 150 carloads of material. Molasses was purchased from the Minnesota Sugar Beet factories and arsenic from the Anaconda Copper Mines of Montana. In all cases the materials were consigned to points as near the infested areas as possible. Shipping points were designated according to the requests of the county leaders.

Establishing Mixing Stations in the County.—Mixing stations in old empty warehouses, lumber yards and other places where shelter was available were established in as many places as convenient for those living in the infested areas. The number of mixing stations depended upon the seriousness of the infestations and the tonnage of materials which had to be handled. As a rule, one mixing station was established in the center of the township. This made it possible for the township supervisor to fully supervise the mixing and distribution of the material. No material was given to any farmer without a written order from the supervisor, and in some counties the written order had to come from the county supervisor. Individual farmers were rarely given any materials. Farmers had to work in crews. In each mixing station two or three mixing boxes were built.

Summer Control Work and Summer and Fall Meetings.—At a second series of meetings and conferences with the county agents and farmers, definite instructions as to control measures were given with demonstrations. In most cases field trips were included. Specialists from the Entomologist's office were sent to these county-wide meetings. County supervisors, township supervisors, bait-scattering crew leaders and farmers were in most cases present at all of these meetings. All subjects pertaining to grasshopper control were thoroughly discussed. Organization; the life history of the grasshopper; mixing of the poison bran mash; when, how, where and in what amounts to scatter the mash; comparison of various kinds of bait and methods of mixing; danger of poison to livestock; methods of destroying grasshopper eggs by working soil, and other phases of the program. Various activities of the organization throughout the field were continually checked during the summer and fall months by men from the Entomologist's office.

A special fall poisoning campaign was arranged to urge farmers to continue the spreading of the poison bran bait where the grasshoppers were beginning to lay eggs. It was pointed out that the cost of poisoning in the fall was only a fraction compared to what it would be the next year if the hoppers were allowed to lay eggs. We pointed out to the farmers that we would be more interested in helping the following season those who poisoned during the fall of the year. It will be noted throughout this paper that procedures and preparations were continually arranged with the assumption that weather conditions would continue to be in favor of the grasshoppers. It would be dangerous to take any other attitude until we were sure that anti-grasshopper weather again prevailed.

CONTROL ORGANIZATION PERMANENT.—We pointed out in our campaign that the grasshopper organization should be made permanent in each county, not only to fight grasshoppers but to provide for the future control of all other insects, rodents and other pests of the farm business. In other words, the grasshopper control organization was to function as an army of minute men prepared to fight insects upon a moment's notice. This set-up makes an excellent organization for the extension entomologist to work through in any problem that he may choose.

SURVEY OF 1932–1933 CAMPAIGN IN MINNESOTA.—It may be well to summarize some of the interesting procedures and accomplishments of the 1932–1933 grasshopper control campaign.

1. Early in January and February of 1932 all of the eighty-seven counties of the state were advised concerning grasshopper control measures. All of the seriously infested counties were warned and given hearings with the State Entomologist and representatives from his office. Where it was found necessary to organize, meetings with the county commissioners were arranged and responsible men were authorized to handle the work in each county with the cooperation of the county commissioners. At least 40 meetings and conferences with county commissioners were held.

2. In advance of and during the campaign of 1932–1933, over forty different circulars of instruction were sent out giving in detail the procedures and other information necessary. A grasshopper control bulletin was written incorporating organization and control measures. Forty to fifty thousand of these have been issued to the farmers of the state upon their request.

3. At least one thousand grasshopper meetings were held in the infested counties. These were conducted by assistants of the State Entomologist or by the county agricultural agents or leaders in the counties. Definite organization plans were presented at the first series of meetings each year. Meetings were held in every infested county and

every infested township. The foundation for a successful campaign was laid in this way.

4. About five hundred carloads of poison bran bait was distributed to the farmers of the state during the campaign of 1932 and about forty-five carloads in 1933.

5. Grasshopper numbers were reduced 90 per cent in fifty-five counties in 1932 and approximately another 6 per cent in 1933, leaving approximately 4 per cent infestation as compared with the tremendous infestation of 1932.

6. The present grasshopper control organization in Minnesota is looked upon as permanent. It constitutes an army of minute men ready to kill grasshoppers, other insects or rodents at any time it should become necessary within the years to come. It cost the state practically nothing to form this organization.

7. This insect control organization which has been established brings together men of all farmer and political organizations in the state with one purpose, and that is to protect the crops from insects and diseases and rodent ravages. Political activities have in no way touched the whole or any part of this organization. Those in charge of campaigns of this kind must be given full authority to act without interference in order to promote successful control.

8. An infestation of approximately five million acres in 1932 was reduced to approximately 528,828 acres in 1933. Approximately $11,000,000 worth of crops were saved in 1932 and approximately $2,600,000 worth of crops saved in 1933. Bearing in mind that weather conditions have, except for few instances, been entirely in favor of grasshopper development for the past five years, these figures indicate that grasshoppers can be controlled.

FURTHER OBSERVATIONS ON THE HAYDITE HIVE

By Leonard Haseman[1]

Two years ago at the New Orleans meeting of the Apiculture Section of the American Association of Economic Entomologists the writer presented a preliminary report on "Haydite as a Substitute for Wood in the Construction of Bee Hives." These studies have been continued, especial attention being paid to the reaction of the bees to the hives and the insulation properties of the Haydite-cement as compared with wood. Since July 1931 two colonies have been housed continuously in these hives with walls approximately one inch thick, one colony in a two-inch wall hive since November 1931, and a fourth colony in a one-inch wall hive since July 1932. Last winter one of the one-inch wall hives was

[1]Contribution from the Department of Entomology, Missouri Agricultural Experiment Station, Journal Series No. 361

partly banked with soil on the sides and back and this winter the thick-walled hive has been banked with soil almost to the top and it will be left mounded in this way next summer, if soil moisture does not prove harmful.

REACTION OF THE BEES TO THE HIVES.—Three of the colonies now housed in these hives were set over from standard wooden hives and they seemed perfectly at home from the beginning. They showed no unfavorable reaction but went about their work the same as those in wooden hives. One of the colonies was introduced as a two-comb package and it went to work and built up the same as other packages which were placed in wooden hives. At no time have any of the colonies shown any evidence of dislike for the concrete hives. Except for sealing cracks, the bees use but little propolis on the bottoms, covers and the walls of these hives. Up to the present time pure Italians and hybrid bees have been apparently just as well satisfied in these hives, both during the winter and the summer, as in standard wooden hives.

HOW THE BEES WINTER IN THESE HIVES.—At the opening of the winter of 1931–32 one hive, which had on an unfilled shallow super, showed some condensation on the under side of the cover, but when the super was removed and a pad to absorb moisture was used no further evidence of harmful condensation occurred. The colonies in these hives came through the mild winter of 1931–32 in unusually good condition with very few dead bees dropped at the entrance following each cold spell. Haydite-cement is said to have about the same thermal properties as wood, but the colonies wintered in these hives seem to respond to changing weather conditions a little more slowly than those in wooden hives. This is especially noticeable in case of the colony in the thick-walled hive. However, when it is warm enough for safe cleansing flights the bees come out from these hives the same as from the wooden hives.

Thus far this winter the colonies are wintering perfectly in these hives and they have withstood sub-zero temperatures. Very few dead bees have been thrown out. They are taking regular cleansing flights on warm days. One of the thin-walled hives has been wrapped in tar paper as extra protection and the thick-walled hive has been mounded with loose soil. Each hive has on a shallow super of surplus honey, the same as in case of the four wooden hives used in the experiments. Our experience with Haydite-cement hives refutes the general notion that hives made of cement are cold and unsuited for wintering bees.

THE HIVE FOR SUMMER USE.—We have had opportunity of observing the reaction of the bees to these hives during the past two rather trying summers. These observations indicate that for brood rearing and for

comfort these hives prove far superior to other hives. At no time, even when the bees in wooden hives were hanging out so as to cover the front of the hives, did the bees in these hives show any evidence of hanging out. On the hottest days some bees would collect on the alighting board and at the entrance, but they did not cluster on the hives. Also, they showed less tendency to swarm than did colonies in standard hives, though swarms emerged normally from these hives last summer as we made no effort to prevent swarming. When these hives were opened the bees always appeared to be cool and comfortable. All of the hives

FIG. 70. Hives used in these observations. The first, second and fourth are Haydite hives, the others standard, 10-frame wooden hives. The first hive has two-inch walls and is mounded with soil on sides and back.

under observation were placed facing south in a young orchard where they received partial shade, but for a portion of the day they were in direct sunshine. During the summer both Haydite-cement supers and standard wooden supers were used on these hives for the storage of surplus honey.

Among other things the suitability of any type of hive is reflected in the total honey produced by bees in such a hive. Two colonies under observation had been in these hives for twelve months when the honey season of 1932 opened. Alongside these were other colonies of the same breeding in wooden hives for the same length of time. The limited number of colonies under observation would invalidate any conclusions which one might draw, but it is interesting to note that in no case did the colonies in the wooden hives produce anything like the amount of

surplus honey that the colonies in the cement hives produced. From our observations during the past two hot dry summers, it seems evident that these hives are entirely satisfactory and we believe more so than standard wooden hives for the rearing of brood and for the storing of honey.

CONCLUSIONS.—Bee hives made of concrete, in which Haydite is used in place of sand and gravel, have proven very satisfactory for housing bees.

We have found these hives favorable for wintering bees and during the summer, from all indications, the bees find them more comfortable than standard wooden hives.

If made properly and handled with reasonable care they should outlast the beekeeper, as they are proof against fire, weather, decay, termites, rodents, and other agencies destructive to standard wooden hives.

Their weight would necessitate the selection of a permanent site for the apiary.

If they should eventually come into common use, only bottoms, brood chambers and covers should be made of this material, standard wooden supers being used for the storing of surplus honey during the summer.

APPLICATION OF THE VARIANCE METHOD TO THE COMPARISON OF GRASSHOPPER BAITS[1]

By FRANK T. COWAN, *Agricultural Experiment Station and Office of State Entomologist, Fort Collins, Colorado*

Due to the increased importance of field experiments, it seems desirable to call the attention of field workers in entomology to some of the more important considerations in plot tests, and to the possibilities of statistical methods in the analysis of the data. Some original researches on the comparative value of different grasshopper baits have been included, together with the detailed calculations for the analysis of variance. In the field of agronomy rather detailed methods of analysis have been worked out and applied to field experiments. Many of these methods are adaptable to the analysis of entomological data. Fisher's analysis of variance is devised for the interpretation of data collected from a small number of plots, and its use to such data will be discussed in this paper.

[1]The main features of this article were given in a paper read at the 17th annual meeting of the Pacific Slope Branch, American Association of Economic Entomologists at Pullman, Washington, June 16, and 17, 1932.

REVIEW OF THE LITERATURE.—Some statistical application has been advanced by field workers in entomology. Many of these, however, are limited in application. The Latin Square as proposed by Hartzell (3) would become unwieldy in analysing a large number of treatments, since this method calls for an equal number of treatments and replications. Bessel's and other formulae used by Hartzell (2) in analysing codling moth data, apply a probable error from a large number of individuals. Such probable errors are themselves subject to too much variability when used with a small number of replications. On the other hand, "Student's" generalised probable error can be used to reduce the error on several treatments so long as they are comparable. Likewise, Student's pairing method, as used by Lockwood (5), is designed primarily for small numbers. Goulden (1) states, "The application of this method is highly desirable for making comparisons between pairs of varieties when the scope of the experiment is limited to a few pairs of observations ..." He further states, "In extensive experiments also, it is impossible to make comparisons of all of the pairs by the direct difference method."

CONSIDERATIONS IN FIELD PLOT TESTS.—*Size and Shape of the Plots:* In entomological research these may differ somewhat from the ones in common use in agronomic work. The following points might be considered as important: (a) Amount of land available, (b) Insect migrations, (c) Drift of spray or dust during application and (d) Type of machinery available.

In entomology, field data are necessarily collected where the particular insect under study is present in fairly large numbers. Ordinarily, such locations are found on privately owned land where the owner may fail to appreciate the precision required in experimental plot work. This situation may seriously affect the size of plots since only those can be used which might be expected to give comparable results.

Furthermore, insects often migrate from one plot to another. Larger plots are often necessary as a result. Migrations are influenced to some extent by weather conditions, especially wind. The wind also has a great effect on the drift of spray or dust from one plot to another; an experiment may be absolutely ruined by this factor so far as comparable results are concerned.

The type of machinery is important in field plot tests that are to be used later in determining control recommendations. This will affect the size and shape of the plots, as large, power-driven dusters and sprayers are not easily adapted to very small plots. Likewise, the labor entailed in spraying large plots with hand machinery is usually too great to con-

sider. This factor-type of machinery—will perhaps influence the shape of the plot to a greater degree than it will the size.

In the final analysis, the size and shape of plots will be decided for the particular case at hand, with due consideration given to all of the above factors. No hard and fast rules can be made. The plots must be large enough to give a sample, uninfluenced by insect migrations or drift of spray or dust. Further, it should be large enough and of such shape that the kind of machinery to be recommended in actual control can be used in making the tests since that is the only way that comparable field results can be obtained. All of these considerations are limited by the amount of land available and the number of replications to be used.

Arrangement of Plots: According to Goulden (1) there are two general methods for the arrangement of treatments, (a) in the same order in each replicate, (b) entirely at random in each replicate. Random arrangement is preferable since any two treatments placed side by side in each replicate may be affected by one another in such a way that the results are correlated. This would introduce a more complicated formula for the determination of correlation between adjacent plots which may be avoided. Random arrangement may be secured by what Goulden terms a "restricted method." By this method plots are not allowed to fall in the same position but once in either the row or column.

Replications: The amount of land available, the number of treatments, and the amount of available time, will largely determine the number of replications. The recommendations given here must be regarded as general because local conditions must be taken into account. Twelve replications were used, in the grasshopper bait work to be described in this paper. Through necessity this number was reduced to 7 the next year, with little apparent decrease in the accuracy obtained. It is altogether possible that the additional work for such a large number of replications in grasshopper bait tests is unwarranted for the small increase in precision. Due to variability between replicates, it is felt that a minimum of 5 should be used. The tentative range may be placed as 5 to 12, altho further experimental work on technic is necessary.

Methods of Sampling: In field work in entomology methods of sampling should receive more attention. It is a problem for each worker for his particular experiment. He may, however, test his method for accuracy by subjecting it to mathematical analysis. For comparing the results of one treatment with another, any method will suffice which approaches accuracy. The number of samples, however, must be representative of the entire population of plots.

Use of Check Plots as a Standard of Comparison: In practically all entomological research in the field, except in the case of a new pest, there has been some standard control method devised. These standard methods should be utilized, where possible, as a check or control with which to compare new treatments. The lead arsenate sprays in codling moth control, and the standard formula for grasshopper baits are good examples. By using these standard treatments as checks new methods can be compared with them to good advantage. In many cases it is advisable to use untreated plots alone or in conjunction with the standard treatments. In most cases, the untreated plots may be included in the final analysis of the data.

MATERIALS AND METHODS.—In order to illustrate the variance method (1) a series of plot tests with grasshopper baits has been chosen. This work was carried out at Fort Collins, Colorado, during the summer of 1931.

The method used in gathering the data is a modification of one worked out by Ford and Larrimer (4) in Indiana. It consisted essentially of laying out plots of a uniform size, scattering the poison baits to be tested on these plots, early in the morning. The plots used in these tests were ¼ acre in size. Sweepings were made at a specified time during the afternoon of the same day and the grasshoppers placed in wire screen cages for observation. The dead hoppers were removed each day, counted, and their numbers recorded. After the third or fourth day the remaining live grasshoppers were removed and their numbers noted. The total number caged and the percentage of kill for the test was then computed.

In this series of tests 12 baits were used. Each one was replicated 12 times. A list of the baits with their respective formulae follows:

Bait No. 1 Bran, arsenic and water (the Basic Formula.)
Bait No. 2 Basic formula plus cane molasses.
Bait No. 3 Basic formula plus beet molasses.
Bait No. 4 Basic formula plus cane molasses and amyl acetate.
Bait No. 5 Basic formula plus beet molasses and amyl acetate.
Bait No. 6 Basic formula plus salt.
Bait No. 7 Basic formula plus cane molasses, amyl acetate and salt.
Bait No. 8 Basic formula plus beet molasses, amyl acetate and salt.
Bait No. 9 Purina sweet roughage plus arsenic, amyl acetate and water.
Bait No. 10 Basic formula plus salt and amyl acetate.
Bait No. 11 Dried beet pulp plus amyl acetate, salt, arsenic and water.
Bait No. 12 "Delicious Hopper" bait. Product of the Raven Honey Dew Mills, Omaha, Nebraska. Formula unknown.

TABLE 1.* TABULATION OF DATA

Bait No. / Rep. No.	1	2	3	4	5	6	7	8	9	10	11	12	Ave. of Rep.	
1	57.6	73.2	59.2	67.9	70.0	38.4	64.8	63.6	29.7	45.0	61.1	60.2	57.5	
2	56.2	65.9	57.1	70.7	81.0	46.6	69.8	42.1	34.7	47.9	56.6	56.1	57.0	
3	40.5	55.0	55.4	60.0	63.8	51.7	75.4	79.6	36.5	62.9	29.7	57.8	55.6	
4	58.2	77.6	76.1	60.5	70.6	57.3	61.8	76.1	53.4	60.8	56.4	62.3	64.2	
5	42.3	55.1	54.0	52.2	49.6	58.0	56.5	60.6	36.9	61.1	51.2	53.9	52.6	
6	68.9	84.3	66.9	76.0	80.4	69.3	60.9	71.7	53.3	69.2	69.6	77.1	70.6	
7	73.0	68.6	66.8	48.7	67.1	36.3	50.0	55.2	39.4	42.4	48.6	53.3	54.1	
8	68.6	61.2	67.3	61.3	64.0	44.4	59.1	64.7	41.3	46.0	36.4	40.1	54.5	
9	67.2	68.0	68.5	60.8	70.9	65.5	55.9	64.4	49.4	59.1	55.0	66.6	62.6	
10	57.0	60.6	57.3	57.3	61.5	57.8	54.3	53.7	40.0	44.2	45.9	51.6	53.4	
11	69.6	76.6	75.4	74.7	72.1	73.1	65.6	72.8	47.2	61.2	56.9	62.9	67.3	
12	74.2	72.5	74.1	70.1	70.0	73.3	62.7	67.8	44.4	57.7	64.1	67.7	66.5	
Average kill	61.1	68.2	64.8	63.3	68.4	55.9	61.4	64.3	42.1	54.8	52.6	59.1	59.6	General mean

*The Latin Square method of analysis is not applicable to these data because the plots were not restricted in the columns.

EXPERIMENTAL RESULTS.—The percentage kill for each bait in each replicate is given in Table 1. The average kill for each bait in the experiment is given at the bottom of the table. The averages for the replicates appear on the right. The general mean was found to be 59.1.

Statistical Analysis of the Data: In calculating standard error for the entire experiment two methods are possible with these data, the Deviation of the Mean method[1] or the Variance method.[2]

The Variance Method was used because it gave a smaller error. It removes variance due to treatments and replications. A small error means more precision in the experiments, which in turn increases the reliability of the results. Due to the fact that this type of analysis has been little used in entomological work it seemed advisable to give all steps in the calculation.

Calculation of the Standard Error.[3] The formula employed and the step by step analysis are given below.

$$SE = \sqrt{\frac{MN\ (\sigma_T^2 - \sigma^2_R - \sigma_g^2)}{(M-1)\quad(N-1)}}$$

M = number of baits tested (in this case 12).

N = Number of replications (also 12).

σ_T^2 = squared standard deviation or variance of all the "kills" of all the baits in the tests.

σ_R^2 = variance of the means of the baits.

σ_g^2 = variance of the mean of the replicates.

$\bar{X}$ = general mean of all baits = 59.6

T = kills of individual baits.

$$\sigma_T^2 = \frac{S\ (T)^2}{MN} - X^{-2} = \frac{532{,}592.36}{144} - 3{,}552.16 = 3698.55 - 3552.16$$

σ_T^2 = 146.39

R = mean kill of all baits.

$$\sigma_R^2 = \frac{S\ (R)^2}{M} - X^{-2} = \frac{43{,}333.22}{12} - 3552.16 = 3611.10 - 3552.16$$

σ_R^2 = 58.94

g = mean kill of the replicates

$$\sigma_g^2 = \frac{S\ (g)^2}{N} - X^{-2} = 43{,}138.29 - 3552.16 = 3{,}594.85 - 3552.16$$

[1]Devised by H. K. Hayes, University of Minnesota.

[2]Sometimes referred to as "Student's" generalised probable error formulae.

[3]Standard Error (SE) has been used here to replace Probable Error (PE) as used by Goulden.

$\sigma_g^2 = 42.69$

Substituting in the formula

$$SE = \sqrt{\frac{12x12\ (146.39 - 58.94 - 42.69}{(12-1)\quad(12-1)}}$$

$$SE = \sqrt{\frac{144 \times 44.86}{121}} = \sqrt{53.26}$$

$SE = 7.298$

SE of a single determination in per cent of the general mean

$$= \frac{7.298 \times 100}{59.6} = \frac{729.8}{59.6} = 12.24$$

$$SE \text{ for the mean of each bait} = \frac{12.24}{\sqrt{12}} = \frac{12.24}{3.46} = 3.53$$

$$SE \text{ for each bait} = \frac{3.53 \times \text{ave. for bait}}{100}$$

Determination of Significance. The Standard error in itself has little value unless it can be used to determine whether or not there are some real differences between treatments. This significance is calculated after the manner suggested by Goulden (1).

SE of difference $= \sqrt{E_A^2 + E_B^2}$†

Where E_A = SE of one treatment

E_B = SE of another treatment

$$\text{Significance of difference} = \frac{\text{Difference}}{\text{SE of Difference}}$$

Discussion.—In Table 2 all baits are listed according to their average kills.

Table 2. Average Kill and Establishing Elimination Level.*

Bait No.	% Kill and SE	SE of Diff.	Diff.	Diff. ¾ SE
5	68.4 ± 2.41			
2	68.2 ± 2.40	3.40	.2	.05
3	64.8 ± 2.29	3.32	3.6	1.08
8	64.3 ± 2.27	3.31	4.1	1.23
4	63.3 ± 2.23	3.28	5.1	1.55
7	61.4 ± 2.17	3.24	7.0	2.16
1	61.1 ± 2.16	3.23	7.3	2.26
12	59.1 ± 2.09	3.19	9.3	2.91
6	55.9 ± 1.97	3.11	12.5	4.02
10	54.8 ± 1.93	3.08	13.6	4.41
11	52.6 ± 1.86	3.04	16.6	5.46
9	42.1 ± 1.49	2.83	26.3	9.29

*In this table all baits are compared with Bait No. 5.

†The formula $E_{A-B} = E_A^2 + E_B^2 - 2r_{A-B}\ E_A\ E_B$ should be used where results are correlated.

In the fourth column Diff./SE the figure is the ratio of the difference in kill between that bait and the one having the greatest average kill, divided by the Standard error of the difference. In this way an "elimination level" has been established at a point where Diff./SE equals two, indicating odds of 22:1. This point is arbitrary depending upon the nature of the tests and the degree of precision required by the worker. Likewise, it is possible to compare any pair of treatments in the series to determine significance.

In Table 2 Bait No. 5 has been chosen as a standard and all other baits are compared with it. It will be noted there is no significant difference between any of the baits above the "elimination level." Bait Nos. 5 and 2 are the only ones that show a significance over Bait No. 1, the basic formula.

Average kill of Bait No. 5 = 68.4 ± 2.41

Average kill of Bait No. 1 = 61.1 ± 2.16

Difference between Nos. 5 and 1 = 7.3

Standard Error of Diff. = $\sqrt{2.41^2 + 2.16^2} = 3.23$

$$\text{Diff./SE} = \frac{7.3}{3.23} = 2.26$$ indicating odds of over 30–1.

Baits 3, 8, 4 and 7 gave higher kills than Bait No. 1, but the difference is not significant.

Conclusions.—The data secured from this experiment indicate that salt is not necessary in the grasshopper bait in Colorado. Bait No. 6, containing salt alone, ranked well below Bait No. 1. Baits 7 and 8, both containing salt, ranked above No. 1, but the difference is not significant. In all probability their position is due to the presence of molasses and amyl acetate.

Amyl acetate seems to be necessary when beet molasses is used, but does not appear to benefit when used in combination with cane molasses.

The data further indicate there is no practical substitute for bran. The two commercial baits, Nos. 9 and 12, gave results comparable to the amount of bran contained in their makeup. Dried beet pulp seems to have possibilities, however, and should be experimented with further in combination with other attrahents.

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EGG DEPOSITION OF THE LESSER BULB FLY (*EUMERUS TUBERCULATUS* ROND.)

By F. S. BLANTON, *Junior Entomologist*, and F. J. SPRUIJT, *Assistant Entomologist*, *Division of Truck Crop and Garden Insects, U. S. Bureau of Entomology*

During the summer of 1931 a study of the relation of the lesser bulb fly (*Eumerus tuberculatus* Rond.) to the basal-rot Fusarium disease was undertaken at the Babylon, (N. Y.) laboratory, and for these experiments large quantities of eggs were necessary.

ATTEMPTS TO INDUCE EGG DEPOSITION.—Attempts were made to keep a supply of eggs for this work by collecting in the field and at narcissus-bulb refuse heaps. Flies were observed to lay eggs at or near the necks of the bulbs on which the foliage was dying, but not enough eggs were found here to meet the demands of the experiment; furthermore, no identifications could be made as to which species of bulb fly had laid the eggs collected in the field. An attempt was therefore made to induce adults to oviposit under confinement. Narcissus bulbs infected with the basal rot were placed in copper screen cages (9 by 4 inches) and from 20 to 100 flies, taken from the general breeding cage, were added. These flies were fed fresh syrup and honey, which was applied directly to the screen. Some of the test cages were placed in the grass and weeds in order that conditions might be as natural as possible. No egg deposition was observed in these tests, although C. H. Martin reported egg laying in tests performed by him during the summer of 1929.

Early in the spring of 1932 these cage experiments were repeated in the laboratory, with flies that had emerged from bulbs that were being forced in the greenhouse. An electric light was suspended over the cage to provide the necessary light and heat. The cages were set over a pan of water in order that there might be sufficient humidity. Even though these experiments were repeated several times, but few eggs were laid.

Later in the spring of 1932 chemicals, including ammonium thiocyanate, carbon disulphide, and carbon disulphide emulsion, were applied to bulbs infested with the bulb nematode. These infested bulbs were growing in tiles in the field and the chemicals were applied directly to

the soil. As a result of these treatments the foliage was severely injured at the ground level and after a few days numerous *Eumerus* eggs, as well as those of other Diptera, were found here. On the basis of these observations bulbs growing in pots were artificially injured, by applying the above-mentioned chemicals, so as to produce a rotting of the foliage at the neck of the bulb, after which the pots were covered with lamp chimneys and the flies were introduced. In addition flats of bulbs injured in the same way were exposed to the natural activities of the lesser bulb fly out of doors. Many eggs were laid under these conditions both in the flowerpots and in the field. After an exposure of four weeks all bulbs in the flats that were chemically treated were infested with *Eumerus* larvae of various sizes, whereas the check bulbs in the same flats were untouched and sound, although the dead foliage and resulting exposed necks afforded ample opportunity for entrance.

The flies for some of these tests were collected at the bulb-refuse heap with an insect net and placed in test tubes, which were then plugged with cotton. It was accidentally discovered that the flies were laying numerous eggs on the glass and in the cotton plugs of the test tubes. These observations were made after a rainy spell and the flies that had been inactive for some time commenced to oviposit at once. Further observations showed that they began laying eggs at once or not at all, and usually laid all their eggs within a few hours after the tests were started. Almost half of the females were observed to lay eggs. The number layed by a single fly ranged from 0 to 143. The eggs were removed from the test tube with a camel's-hair brush, and the species of fly was determined. All other means of obtaining eggs were then abandoned, as this was the most convenient method.

TABLE 1. SUMMARY OF OVIPOSITION DATA OF *Eumerus* FLIES CONFINED IN TEST TUBES

Date	Number of flies	Number of eggs	Average number of eggs per fly
June 15	7	162	23.1
22	3	170	56.7
30	16	645	40.3
July 8	3	97	32.3
9	5	133	26.7
14	12	254	21.2
18	8	307	38.4
Aug. 2	6	240	40.0
15	8	153	19.1
19	13	307	23.6
29	9	440	48.9
Total	90	2,908	32.2

After this discovery observations were made of the oviposition of a total of 90 flies confined in test tubes between June 15 and August 29, 1932. The results are summarized in Table 1.

OBSERVATIONS OF FLIES DURING OVIPOSITION.—Flies in the act of oviposition were observed in the field and at the bulb-refuse heap. The best time to make such observations is during the middle of a warm day when the sun is shining brightly, especially if it has been rainy or cloudy during the morning hours to keep the flies inactive. The female flies slowly, hovering about 2 inches above the ground, circling about and alighting many times. When she finds a desired spot she begins to oviposit. A desired spot is usually at the neck of the bulb either on the foliage or beneath the dry scales of the bulb, or on soil close to the bulb. At the bulb-refuse heap the fly may lay at any place near a discarded bulb, but always in a dry spot, and the eggs are placed so that the direct rays of the sun do not strike them. The female usually prefers to find a place where she can hide from view. Under such conditions it is hard to make observations, but sometimes obstacles can be removed without causing the fly to cease ovipositing. The flies often leave after depositing several eggs and return shortly to add more to the number. Several flies will lay eggs on the same bulb.

In the test tubes most of the eggs are deposited on the cotton plugs, although eggs are sometimes placed on the glass. Most of the eggs are deposited during the first afternoon in captivity. The ovipositor is distended and moved back and forth very rapidly. The flies sometimes lay many eggs without moving, but they are usually very nervous, laying about half a dozen eggs and then moving around for a short time before laying more.

OTHER DIPTERA OVIPOSITING IN TEST TUBES.—Other dipterous insects were as easily induced to lay eggs in test tubes as was the lesser bulb fly. They would also lay in the lamp-chimney cages as described above. Flies other than *Eumerus* that laid eggs under caged conditions are as follows: *Syritta pipiens* L., *Eristalis aeneus* Scop., *Delphinia picta* Fab., *Seioptera vibrans* L., *Rivellia viridulans* Desv., *Callopistromyia annulipes* Macq., *Idana marginata* Say., *Euxesta notata* Wied., and *Chaetopsis aenea* Wied.

THE SOUTHERN PINE BEETLE IN PENNSYLVANIA (*DENDROCTONUS FRONTALIS* ZIMM.)

By J. W. KNULL, *Forest Research Institute*

The southern pine beetle has appeared in the southern part of Pennsylvania, and during the winter of 1932–33, many areas of infestation were located in Franklin, Fulton and Bedford Counties. Although the northern range of the insect is recorded as extending across the southern part of the State, records of its capture are few and serious outbreaks up to the present time are practically unknown.

Observations of exit holes on old dead standing trees indicate that the insect was not present in any number several years ago. It is quite probable that it appeared during the summer of 1930 when exceedingly high temperatures and drought conditions were experienced. The beetle has been on the increase since that date due to mild winters and ideal breeding conditions. In practically all of the heavily infested areas on the Mont Alto State Forest, old brood trees could be seen nearby.

The growing seasons of 1930–31 were greatly deficient in rainfall, with high temperatures and torrid winds. These conditions lowered the vitality of many thrifty trees and actually reduced them to the condition of over-ripe trees. In addition to this, the rainfall during 1932 was not sufficient to replace much of the ground water lost during the drought. It has been shown by Blackman,[1] Craighead[2] and St. George,[3] that deficiency in rainfall and bark-beetle outbreaks can well be correlated. In view of the fact that southern Pennsylvania is the northern range of this insect, mild winter weather with few sudden drops in temperature would be ideal for the overwintering of this species in the brood trees. The following climatological data[4] will give an idea of climatic conditions at the nearest weather stations. Complete records are not available for Arendtsville, or Mont Alto. Arendtsville records would probably approximate conditions at Mont Alto more closely than either Gettysburg or Chambersburg.

Using the average precipitation of the last ten years as normal rain-

[1]Blackman, M. W., 1924. The effect of deficiency and excess in rain fall upon the hickory bark-beetle. Jour. Econ. Ent., Vol. 17, pp. 460–470.

[2]Craighead, F. C., 1925. Bark-beetle epidemics and rainfall deficiency. Jour. Econ. Ent., Vol. 18, pp. 577–586.

[3]St. George, R. A., 1929. Weather, a factor in outbreaks of the hickory bark-beetle. Jour. Econ. Ent., Vol. 22, pp. 573–580.

[4]Bliss, G. S., 1923–1932. Climatological Data. U. S. Dept. Agriculture, Weather Bureau. Weather Records, Forest Research Institute, Mont Alto, Pa.

fall, there was a deficiency of 24.02 inches at Chambersburg in 1930–32. During the same period there was a deficiency of 24.17 inches at Gettysburg.

Station and year	Temperature (degrees Fahrenheit)			Precipitation (inches)			Sky
	Annual mean	Highest	Lowest	Total for year	Departures from normal	Total snowfall	Clear days
Chambersburg							
1932.....	54.3	102	3	39.67	.65+	21.9	118
1931.....	55.8	102	12	34.42	4.60—	12.1	117
1930.....	52.1	105	—12*	19.60	19.42—	22.1	144
Av. 1923–32...	52.21	105	—13	39.02		29.88	133.5
Gettysburg							
1932.....	54.8	98	2	49.62	8.51+	19.0	175
1931.....	55.8	102	12	34.42	6.69—	12.1	117
1930.....	54.3	103	— 6*	23.63	17.48—	19.0	177
Av. 1923–32...	53.57	105	— 6	41.11		28.66	142.2
Arendtsville							
1932.....	52.1	98	4	48.47		20.2	227
1931.....	54.7	101	9	35.68		21.7	202
1930.....	52.2	106	— 3*	24.31		20.3	177
Mont Alto							
1932.....	53.2	99	6	44.51			191
1931.....	54.3	99	11	35.85			185
1930.....	54.0	103.0	0*	20.31			210

*January 20th.

As pointed out by Beal,[5] the temperature also plays an important part in the mortality of the overwintering stages of the southern pine beetle. Beal found that air temperatures as low as 10° F. for short periods resulted in the mortality of many larvae. During the winter of 1930–31 the minimum temperature at Chambersburg and Gettysburg was only 12° F. In 1931–32 the minimum was 3° and 2° F. respectively. Beal[5] also found that there was a higher mortality of overwintering stages in the phloem than in the outer bark, due to moisture content. This observation was also corroborated in Pennsylvania.

For the most part slowly growing trees seemed to suffer worst. However, numerous moderately rapid growing trees were found to be infested also. Many over-ripe trees were attacked and pines surviving recent fires seemed to suffer severely.

[5]Beal, J. A., 1927. Weather as a Factor in Southern Pine Beetle Control. Journal of Forestry, Vol. 25, pp. 741–742.

Beal, J. A., 1933. Temperature Extremes as a Factor in the Ecology of the Southern Pine Beetle. Journal of Forestry, Vol. 31, pp. 329–336.

A pine area in southern Bedford County, on the west side of Tussey Mt. showed large acreages of infested trees in the winter of 1932–33. Fire had been in this area about twelve years previous and many of the pines which survived showed slow growth. This was probably due to fire injury to the roots. Several windfalls on the Mont Alto State Forest were responsible for sporadic outbreaks. In some cases lightning strokes seemed to be responsible for isolated infestations.

The most northerly infestation was observed in the white pine in Horse Valley, two miles south-west of Roxbury. However, pitch pine brood trees, containing living larvae were found on the summit of Martin's Hill, Bedford County, at an elevation of approximately 2,900 feet. These larvae survived the 1932–33 winter.

Pitch pine, shortleaf pine, table mountain pine, white pine, and Virginia scrub pine were all found to be infested. The thickness of the bark varies with the species and is in the order named, pitch pine being the thickest. The bark of the second growth white pine is rather thin in comparison with that of pitch and shortleaf pine. Although infested white pines were found, infestations of this tree were not numerous. No pupae were observed during the winter but living adults and larvae were abundant in the larger pitch and shortleaf pines. In the other species mentioned, the winter mortality was great.

Aside from the parasites and predators found in the infested bark, woodpeckers had done excellent work in keeping down the numbers of the pest. As pointed out by St. George[6] the birds scale off the outer bark from the brood trees and feed on the cream colored larvae which are picked from the cells beneath. Many of the larvae which escaped the birds perished due to lack of bark remaining for their protection from the elements. Brood trees worked on by woodpeckers resembled trunks of Scotch pine at a distance.

In connection with trees killed by the beetle, it is interesting to note that the basal portion of many of the thick barked hard pines contain many *Acanthocinus nodosus* Fab. larvae. This is a southern species and rather rare in Pennsylvania. The larvae were found to be unusually abundant in the parts of the bark which extend just below the ground litter. It is another case of a southern species becoming abundant during the last few years.

[6]St. George, R. A., and Beal, J. A., 1929. The Southern Pine Beetle: a Serious Enemy of Pines in the South. U. S. Dept. Agr. Farmers Bulletin 1586.

St. George, R. A., 1931. An Instance of Natural Control of the Southern Pine Beetle. Forest Worker, Nov., p. 16.

Scientific Notes

The European Corn Borer in Egypt. With reference to the note by Mr. A. H. Rosenfeld in Volume *26*, page 1172, of this journal, I should like to put on record the following additional information: In August 1925 I found a small but quite definite infestation of the European Corn Borer in maize in the neighborhood of Alexandria. Quite a number of stems were seen characteristically bent over at the point of injury and a number of larvae were secured. In view of the interest in the species throughout Europe and America, I planned to put on an investigator to study the insect in this locality to find out if by any chance the presence of efficient parasites was the cause of its rarity. No opportunity occurred to do this until about one year later when the investigator spent a considerable time in the same locality without being able to find a single specimen. I also visited the locality myself about that time with the same result; not a single specimen could be found although the maize was in the same state of growth. I have a recollection that I informed Dr. L. O. Howard at the time of this discovery.

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General Observations on the Lima Bean Vine Borer (*Monoptilota pergratialis* Hulst) on the Eastern Shore of Maryland During 1933. On June 21, 1933, the county agricultural agent of Wicomico County, Md., informed the writer that he was receiving numerous complaints from growers regarding damage to Fordhook lima bean plants caused by the lima bean vine borer (*Monoptilota pergratialis* Hulst). He stated that some injury had been observed in previous years but that the infestation during 1933 was the most severe that he had ever seen. A review of the literature indicates that this pest has been present in Maryland since 1928.

On June 21, 1933, larvae of the insect were obtained by splitting the stems of Fordhook lima bean plants and several of these were taken to the laboratory at Norfolk, Va., where they were placed in a cage with food. The larvae pupated July 3 and moths emerged on July 13. These moths were immediately placed in a field cage in which a Fordhook lima bean plant was growing but died on July 18 and 21, respectively, without depositing eggs.

Further field observations were made in Maryland on July 24. At this time no larvae were found although exit holes in the stems of several plants were seen and larval tunnels inside the stems were found. This period was probably between generations, as indicated above by the fact that moths emerged in the insectary on July 13 and were active until death occurred on July 21.

On September 21, field examinations were again made and larvae were found inside the stems of practically all of the plants examined. As many as 3 larvae were found inside the stem of one plant. Larvae collected in the field on September 21 started pupating in the insectary on September 25. Examinations made on March 16, 1934, revealed that the insect passes the winter in the pupal stage on or near the soil surface.

The larva burrows in the stalk, causing a gall-like enlargement. Plants thus weakened soon wither, and are easily broken by the wind and killed. When ready

to pupate, the larva bores an exit hole in the stem and drops to the ground, where it pupates in a silken cocoon covered with earth.

From observations made during the 1933 season it appears that at least two generations of the insect develop in Maryland in a season.

Growers stated that damage appeared more severe in light sandy soils than in heavier soils.

Since the winter is passed in the pupal stage on or near the soil surface, it appears that fall plowing and cultivation will aid in controlling the pest.

L. W. BRANNON, *Assistant Entomologist, Bureau of Entomology, U. S. Department of Agriculture*

An Insectivorous Range Lizard in Pasture Insect Control. The sagebrush swift, *Sceloporus graciosus graciosus* (Baird and Girard), was found to be abundant among the brush in a rabbitbrush and grass pasture west of Orem, Utah County, Utah. During 1932, 198 specimens of this common lizard were collected and their stomachs examined. The stomach contents consisted of 76 Orthoptera, mostly grasshoppers; 6 Neuroptera; 218 Homoptera, of which 200 were aphids and the remainder leafhoppers, including 3 beet leafhoppers, *Eutettix tenellus* (Baker); 45 Hemiptera, of which 14 were predacious big-eyed bugs, *Geocoris decoratus* Uhl.; 42 Coleoptera, of which 6 were ladybird beetles; 103 Diptera; 91 Lepidoptera, of which 82 were caterpillars; 430 Hymenoptera, of which 344 were ants; 13 spiders; 1 symphyllid; many insect fragments; and a few plant fragments and seeds. In addition, one stomach contained a partly digested half-grown sagebrush swift. Fifty-three of these stomachs contained grasshoppers and the same number contained ants. During 1933, this pasture was visited twice, once in June and again in September, 120 specimens of the sagebrush swift being taken upon these occasions. The distinguishable stomach contents of these specimens consisted of 73 Lepidoptera, 56 of which were caterpillars; 32 Homoptera, including 18 leafhoppers (one of which was a beet leafhopper) and 6 aphids; 72 Orthoptera, all of which were grasshoppers, 55 of them nymphs; 54 Coleoptera; 46 Hymenoptera, including 33 ants; 44 Hemiptera; 80 Diptera; 1 Thysanoptera; 21 spiders; 16 parasitic roundworms; and 2 plant fragments. Injurious species found in the stomachs included tarnished plant bugs, false chinch bugs, pentatomids, grasshoppers, caterpillars, and numerous other forms. Approximately 30 predacious specimens were found to have been ingested. The bulk of the recognizable forms were either injurious or had no known beneficial rating.

GEORGE F. KNOWLTON, *Utah Agricultural Experiment Station, Logan, Utah*

Tortrix ivana **Fernald, A Celery Pest in the Everglades of Florida.** Mr. R. N. Lobdell of the Everglades branch of the Florida Agricultural Experiment Station near Belle Glade, Fla., and the writer made an examination a few miles southeast of the station on January 16, 1933, of a celery field in which an outbreak of the celery leaf tier (*Phlyctaenia rubigalis* Guen.) had been suspected. Eggs and larvae of the insect responsible for the damage were collected from the field and reared on celery in the laboratory at Sanford, Fla. The larvae were easily distinguished from those of the celery leaf tier by their olive-green appearance and the darker brown color of the cervical shield and head capsule. The mature larvae were somewhat smaller than those of the celery leaf tier. The adult moths were identified in the Division

of Identification and Classification of Insects of the U. S. Bureau of Entomology at Washington, D. C., as *Tortrix ivana* Fernald. An egg parasite, *Trichogramma minutum* Riley, emerged from some of the eggs taken in the field, and two species of undetermined hymenopterous parasites emerged from the larvae.

The infestation in the younger celery was especially noticeable in the field because the tops of the plants presented a wrinkled or curled appearance due to the feeding of the small larvae on the under surfaces of the leaves. An average of about 2 larvae per plant had been present in the small celery. About one-sixth of the stalks of the nearly mature celery, especially on one side of the field, were so badly damaged that they were unmarketable. The small larvae first fed on the leaves beneath their webbing and then, as they became larger, migrated downward to the heart of the plants and attacked the inside surfaces of the petioles, where the damage became commercially serious. The injury to the petioles resembled very closely that of cutworms with the exception that the larvae always fed beneath a thin, tough, white web and produced considerable frass. A number of the larvae were taken on a wild host, Rabbit Tobacco (*Gnaphalium obtusifolium* L.), which grows commonly on the cultivated lands and along ditch banks in the Everglades.

Other outlying fields showed very little injury, but should the growing of celery in the Everglades become concentrated in large areas it is likely that this insect may become a pest of major importance. Occasional specimens of two very similar species of caterpillars, *Cacoecia rosaceana* Harris and *Cacoecia obsoletana* Walker (det. Schaus), frequently have been taken on celery in the Bradenton and Sanford, Fla., celery areas.

CLARENCE O. BARE, *U. S. Bureau of Entomology*

The known distribution and habits of *Plectris aliena* Chpn. *Plectris aliena* Chpn., a recently described melolonthine scarab, is now established in the southeastern part of the United States. The point of greatest abundance is Charleston, S. C. While the natural habitat is unknown, the beetle is presumably indigenous to northern South America where *Plectris* and other closely allied genera have their centers of distribution. At Charleston the beetle is very common in the lawns in the western part of the city. It was found wherever searched for in the area west of King Street from just north of Battery Park to the north limit of Hampton Park. Outside of Charleston, specimens have recently been taken in Japanese beetle traps at Savannah, Ga., and Miami, Fla.

The species seems to be single brooded. In June 1933 the writer was able to collect a first-instar larva, two diseased pupae, females in the process of depositing eggs, and an unlimited number of males. The search made was adequate to have disclosed partly matured larvae had they been present.

Pupation occurs at a depth of about 11 inches in the soil beneath lawn turf. Egg laying occurs at the same depth. A female of apparently normal development deposited at least 14 eggs in a cavity prepared by her. At dusk, males emerge from the turf in large numbers and after flying rapidly about for about 20 minutes return to the ground. No specimens were collected at street lights in the immediate neighborhood of any infested lawn nor could any be found in the rather abundant shrubbery at the edges of lawns. The species is active from March to July, according to dates on collected specimens. A recent report, through the Japanese Beetle Research Laboratory, states that considerable injury to a golf links near Bruns-

wick, Ga., is being caused by this species. As some of the larvae from the links have been reared to the adult stage, the determination of the species is certain.

EDWARD A. CHAPIN, *U. S. Bureau of Entomology, Washington, D. C.*

Further Observations on Limiting Factors in Codling Moth Bait and Light Trap Attrahency. During the past seven years investigations have been in progress at the New Mexico Agricultural Experiment Station to determine the value of various aromatic baits and illuminating devices in the control program for the Codling moth. As a result of these studies a slowly fermenting bait of cane syrup (Jl. Ec. Ent. 24: 3, 1931) has been developed to capture the adults during periods of high temperatures and frequent precipitation. Also the value of an illuminated electrified grid, perfected and manufactured by the Folmer Electracide Corporation, as an additional assistance in capturing and retaining the moths has been emphasized (Jl. Ec. Ent. 25: 1246, 1932).

Studies of the chemistry of fermenting syrup baits indicated that their attractiveness was apparently due to aromatic esters evolved during the process of fermentation and gas formation. Moreover, certain commercially manufactured esters approached syrup baits in attractiveness, notably (1) isobutyl phenyl acetate, (2) ethyl oxyhydrate and, (3) geranyl formate. These esters are aromatic monobasic acids or their derivatives and altho resembling the aroma of apple blossoms or fruit have little close similarity in chemical composition. Due to the fact that the exact chemical basis for the attractiveness of fermenting syrup baits and their attendant esters as well as commercially prepared esters has not been ascertained, progress along the lines of developing more attractive baits for the Codling moth has been somewhat haphazard and empirical.

Altho the exact nature of the inherent attractive principle of these baits is still unknown, it has been possible to show by statistical analysis the significance of these baits in comparison with such chance external factors as position in the tree, exposure to light, wind currents, etc., (43rd Ann. Report, N.M. Agr. Exp. Sta., 1931–32). It has been demonstrated during our past two seasons' investigations along these lines that the composition of both the fermenting syrup and ethyl oxyhydrate baits has a significance of 2–16 times that of the other factors. Moreover, when the bait or light traps are given western, southwestern, or northwestern positions in individual trees or plots, which under New Mexico conditions, involve greater exposure to prevailing westerly winds and sunset light intensity, higher catches are secured. This is in partial agreement with similar observations recently published by Worthley in Pennsylvania (Jl. Ec. Ent. 25: 3, 1932).

With respect to our common knowledge of the chemotropic and phototropic responses of the insect, the investigations in New Mexico are in agreement with the following observations made by investigators in other parts of the country:

1. The major nocturnal activities of the moths occur at two distinct periods namely, a flight period around sundown when 60–70% of the moths are active and a second period at sunrise when 15–20% are in flight.

2. Moth activity normally occurs at light intensities of approximately 30–50 foot candles. (In this connection it has been observed that artificial lights producing these ranges of intensities prolong the flight periods and consequently the nocturnal visitations to attrahent baits when they are used in conjunction. Lights above or below these intensities exerted slight effect or were repellent.)

3. Nocturnal temperatures above 80° F. as well as those below 60° F., inhibit moth flight and hence decrease their responsiveness to both baits and lights.

4. Irrespective of whether the attrahent is a bait, a light, or a combination of the two, the sex ratio was approximately equal altho usually more males than females have been captured, the ratio being approximately 55% males and 45% females.

J. R. EYER, *New Mexico Agricultural Experiment Station*

The Life Histories of Three Newly Imported Predators of the Red Scale. Early in 1933 the University of California imported three new species of predators on red scale: two coccinellids, *Pharoscymnus horni* Weise and *Telsimia emarginata* Chapin, and a nitidulid *Cybocephalus*. These insects were collected in the Orient by H. Compere. Large numbers were reared in the insectary at the Citrus Experiment Station on red scale infesting cycads and liberations were made at intervals in different sections of southern California. None of the insects have been recovered.

The genera represented by these species are largely feeders on coccids. *Cybocephalus californicus* is a predator on the cypress box scale, *Ehrhornia cypressi* (Ehrhorn). The genus *Fiorinia* is attacked by *C. nigritulus* Lec. The group *Cybocephalini* is distinct from other members of Nitidulidae in having all tarsi four-jointed, a contractile body, and a thorax margined at the base and covering the base of the elytra. *Telsimia nitida* is reported as controlling *Aspidiotus destructor* in Guam.

Telsimia emarginata. Sexes of *Telsimia* may be distinguished by the semicircular marginate apex of the fifth sternite of the male. The newly laid egg of *Telsimia emarginata* is yellowish red or light lemon color. It is typically egg-shaped, 1/3 mm. in length, and 1/5 mm. its largest diameter. Just prior to hatching it turns dark gray. It is usually deposited in crevices but may often be observed on the surface of the host or host plant. The shell of the egg is very finely punctate. The larvae are dark gray at hatching and a few hours after large lateral wax filaments appear, one pair to each segment of the body except the head. A very noticeable feature is its large strong legs. The full-grown larvae usually migrate downward and pupate in crevices. The pupa is yellowish red and is partially covered with the white wax of the last larval molt. It is covered with short fine hairs which are tipped with globules of wax a few hours after pupation.

Pharoscymnus horni. The newly laid egg of *Pharoscymnus horni* is light reddish brown, somewhat kidney-shaped, 2/3 mm. in length, and 1/3 mm. in width. The eggs are deposited in crevices or debris. The newly-hatched larvae are dark gray and throughout the larval period are without wax. The fullgrown pupae attach themselves to the ventral surfaces of the plant and pupate. The pupa is of a dark olive color and covered with wax hairs, which are tipped with globules of transparent wax a few hours after pupation.

Cybocephalus sp. The sexes of the red scale feeding species of *Cybocephalus* are readily distinguished by color differences. The female is jet black but the male is partially yellow. The newly-laid egg of *Cybocephalus* is translucent pale lavender, oval-shaped, 1/2 mm. in length, and 1/5 mm. in width. The egg is deposited in the vacated male host scales, or beneath the mature female scales. Before hatching it becomes splotched with purple. At hatching the larvae are white with sparse long hairs. For the most part they feed on adult female scale, when they are

usually completely concealed beneath the scale covering. About four days before pupation the larva spins a round parchment-like white cocoon in the soil or debris.

LIFE CYCLES AT A FAIRLY CONSTANT TEMPERATURE OF 82° F.

	Total life cycle	Egg	1st instar	2nd instar	3rd instar	4th instar		
						Feeding	Prepupa	Pupa
Pharoscymnus hŏrni	26 days	8	3	2	3	3	2	5
Telsimia emarginata	30 days	5	4	3	3	10	6(?)	5
							Cocoon	
Cybocephalus sp.....	24 days	5½	2	2	2	1	4	7

Note: The adult Cybocephalus remains in its cocoon 3 days before cutting its way out.

S. E. FLANDERS, *Division of Entomology and Parasitology, Berkeley, Calif.*

Trichodes ornatus **(Say).** One of the commonest clerid beetles in the West is the beautiful brilliant metallic blue and yellow *Trichodes ornatus* (Say), which occurs abundantly in the flowers of many plants and may be collected throughout the entire western half of the United States from the Dakotas and Nebraska to the Pacific Ocean and from Arizona to Alaska. Many speculations have naturally been made regarding the life history of this beetle but to date very little exact information has been obtained. On this point a rather interesting bit of evidence has been obtained which appears to be worth recording.

On October 1, 1931, G. H. Vansell took, at Strawberry on the Placerville-Tahoe Highway, a single cell of a mason bee which was securely fastened to a large granite boulder. This bit of masonry was constructed of particles of decomposed granite, the inside layer being of very minute granules and the outer layer of rather coarse pebbles the size of rock salt. The cell fell to pieces in removal and exposed a beautiful bright red larva about one-third of an inch long. There was no difficulty in determining the fact that it was a clerid, but beyond that nothing was known. The specimen, together with the contents of the cell, was placed in a small glass vial and securely stoppered. After some months it was noted that the larva had bored into the cork and was completely concealed. On January 6, 1932, the cork was cut open and the larva was found alive and healthy. Piecing the cork together again and inserting it back into its original place in the vial, the cell was restored more or less to its natural condition. On November 16, 1933 the larva was observed to have pupated and on November 26, 1933, the adult beetle emerged. It is to be inferred that the larva was apparently parasitic on the larva of the mason bee. The adult beetle perhaps laid its egg in the cell as it was being constructed by the bee or the larva may have entered through a small hole which was not noticed when the cell was removed.

E. O. ESSIG

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

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The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $3.00 per page. There is a charge of $3.00 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

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A. A. A. S. Winter meetings, 1934-1935, Pittsburg: December 1935, St. Louis; Summer meetings, 1934. Berkeley, June 18-23; 1935, Minneapolis.

Much of the Eastern Seaboard is in the grip, if one may use that term, of a tent caterpillar outbreak. The pests are full grown, and the stripped wild cherry with their thousands of caterpillars are evident to all. There is, at this writing, a very considerable popular interest in the control of this pest, and yet it was difficult to secure action some four to six weeks earlier when control was relatively easy and the present unsightly conditions could have been prevented. The psychology of the situation is interesting. The widespread stripping was forecast. The primary difficulty was that this tent caterpillar, although a nuisance and a cause of unsightly conditions, is not of sufficient economic importance to justify organized control, except under certain special conditions.

A very different situation occurred in Minnesota last year when extensive areas were threatened by hordes of grasshoppers capable of widespread destruction to valuable crops. Here was the basis for an effective campaign. The opportunity was seized and those interested in what may be termed really effective economic entomology are advised to study carefully the somewhat detailed account of the campaign as presented in this issue. There was, first of all, a somewhat general knowledge of the destructive potentialities of grasshoppers. The presence of abundant eggs in different sections of the State was demonstrated. The active interest and support of local and state agricultural and business leaders were enlisted. The proposition was presented to the Legislature and the Governor, and concerted, well directed effort resulted in the efficient

handling of a situation which threatened disaster to important agricultural interests of Minnesota. The trained entomologist was the prime mover in this undertaking, and yet he would have failed if he had not enlisted the cooperation of the various agencies vitally concerned in agricultural welfare.

Reviews

Bumblebees and Their Ways by OTTO EMIL PLATH, with a foreword by WILLIAM MORTON WHEELER, pages i–xvi, 1–201, 11 Plates (2 colored), 20 text figures, The Macmillan Company, New York, 1934.

Almost everyone recognizes a bumblebee. Few know bumblebees. Such knowledge can be gained only at some personal risk and the large majority are content to leave these pugnacious creatures severely alone. The author, impelled by a love of Nature and the driving curiosity of the scientist, has spent 13 years in studying these common insects and their ways, and in this volume has brought together a most readable summary of our earlier knowledge and a pleasing digest of his investigations, the account being well illustrated. Chapters are devoted to founding a colony, the bumblebee colony in midsummer and the climax in the development of the colony. There are excellent discussions of the cuckoo bumblebee or Psithyrus, the Commensals or associates, parasites and predators, the method of protecting and defending the nest and brood (most boys know something of this), and a rational and presumably accurate explanation of that peculiar phenomenon known as the "trumpeter bee." The author has a chapter devoted to hibernation and another to the rearing of colonies in artificial nests. He describes his method of finding and transferring colonies, favors us with a discussion of the economic importance of bumblebees and has worked out a classification based on behavior. The appendix consists of detailed, concise accounts of American species of bumblebees and of Psithyrus, each account descriptive of character and habits and with a map indicating the geographical distribution. There is an extensive, well selected bibliography and a detailed index.

This interesting account and guide to bumblebees and their habits should stimulate others to enter this fascinating and comparatively unexplored field.

E. P. FELT

Current Notes

Dr. Frank H. Lathrop has been appointed Entomologist at the Maine Agricultural Experiment Station to succeed the late Dr. Clarence R. Phipps. Doctor Lathrop will assume his new duties August first.

Mr. James Marshall M. S. left on April first to resume his duties at the Entomological Laboratory, Wenatchee, Washington, after having spent several months taking graduate studies at McGill University (Macdonald College).

Officers of the Entomological Branch, Foreign Pest Suppression Division, throughout Canada have been co-operating with the Belleville Parasite laboratory in connection with the natural control of the greenhouse white fly. Parasites of this insect, reared at Belleville, have been distributed to a large number of growers for liberation in their greenhouses. These are in great demand.

Dr. E. F. Phillips, President of the American Association of Economic Entomologists, represented the organization at the Centenary Celebration of the University of Delaware, Newark, May 11 and 12. It may be noted in this connection that Dr. L. A. Stearns, Head of the Department of Entomology at the University, is a Vice President of the Association and Chairman of the Eastern Branch.

Investigational work on the early stages of grasshoppers and cutworms, and studies of conditions controlling the development of wheat stem sawfly have been continued at the Entomological Branch Laboratory, Lethbridge, Alta. Material progress has been made in each project. Among points of particular interest are that grasshopper eggs in Manitoba and northern Saskatchewan are apparently somewhat behind those in the Estevan and Lethbridge areas in development; that the studies of oils in hopper baits are showing distinct promise, and that alfalfa meal by-products are being explored as substitutes for bran in baits. The studies of the reactions of young cutworms to soil humidity suggest that therein may lie a partial explanation of the rapid increases of these insects in certain seasons.

A four day session of entomologists was completed March 2 at Purdue University, Lafayette, Indiana. More than 125 entomologists, representing 20 states and Canada, attended.

The session of February 27 dealt with the National Codling Moth situation, with B. A. Porter of the U. S. Bureau of Entomology in charge. This session continued over the following day. This was perhaps the most complete and representative Codling Moth conference ever held in the United States.

On February 28 the Central States Plant Board held its annual meeting, with Dr. H. B. Hungerford of the University of Kansas as Chairman, and Paul Ulman of the Indiana State Entomologist's Office, Secretary.

March 1 and 2 the 13th annual meeting of the North Central States Entomologists was held with J. J. Davis of Purdue University acting as Chairman, and W. B. Noble as Secretary. The Conference of North Central States Entomologists is an informal organization, no prepared papers being on the program. Instead, subjects for discussion are submitted by those interested and persons assigned to lead the discussion. In this way it has been possible to retain a free and unlimited discussion of all important problems.

The Annual Dinner was held the evening of March 1, the President of Purdue University, Edward C. Elliott, acting as toastmaster. The dinner tables were decorated with ornamental beeswax candles supplied by the A. I. Root Co.

Horticultural Inspection Notes

M. S. Yeomans, State Entomologist of Georgia, reports that his office was forced to discontinue the services of one Assistant Entomologist and one Inspector, effective January 15th, last, on account of reduced appropriations.

The Michigan State Department of Agriculture gives a report of the Orchard and Nursery Inspection Service for 1933 in bulletin No. 68. It is noted that the license fee for out-of-State nurserymen has been changed from $5 to $25.

The Idaho State Department of Agriculture, on August 10, 1933, placed a quarantine relating to the downy mildew of hops, which prohibits the entry of all hop roots or hop plants from the State of Oregon, the counties in Washington west of the Cascade Mountains, and the Province of British Columbia.

Those firms in the viciniy of Barre, Vt., which cut stone under conditions such that no gypsy moth infestation would be possible, are being placed under a monthly permit system of gypsy moth certification instead of having each individual shipment inspected and certified.

An outline of the plant quarantine import restrictions of the Philippine Islands was issued by the Bureau of Plant Quarantine on May 1, as circular BPQ–363. A similar outline of the plant quarantine import restrictions of the French Mandate of Syria has been issued as BPQ–364.

W. A. McCubbin of the Bureau of Plant Quarantine went to the Pacific Coast late in February to investigate the possibility of eradicating an infestation of *Dialeurodes chittendeni*, a rhododendron white fly which apparently had accidentally been introduced from England. Preliminary surveys show that the white fly is present in several different plantings and the question of possible future action is now under consideration by the Federal and State departments of agriculture.

The potato wart quarantine of West Virginia was revised effective April 15 "in order to incorporate the more recent research on this disease." In certain areas seed potatoes may be purchased only from an authorized source, thus insuring the planting of immune varieties in diseased soil. In other areas any variety may be planted under permit. The right of the commissioner of agriculture to require treating of the soil to eradicate the disease has been placed in the new quarantine. State supervision of plowing is required. The areas involved are located in the Counties of Tucker, Grant, and Randolph.

The State of Oregon, on March 28, revised the intrastate quarantine relating to the white-pine blister rust, apparently again to bring the requirements into conformity with the latest revision of the Federal quarantine on the subject. A permit is required, as heretofore, for shipping five-leafed pines intrastate, and the requirements for movement of currant and gooseberry plants from place to place within the State are commensurate with those of the Federal quarantine, including the embargo on the shipping of prohibited species.

A new infestation of the white snail (*Helix pisana*) has been found in several orange groves in the vicinity of Anaheim, Orange County, Calif., and the intra-

state quarantine applying to that county has been extended to cover the additional area. As heretofore, a complete embargo is placed on the movement out of the infested area of native plants and soil, and certification is required for moving other plants, fruits, vegetables, hay, forest plant products, construction material, and farm machinery.

The eradication of wild cotton in southern Florida carried out by the Bureau of Plant Quarantine continued until the arrival of the rainy season in May made further work impossible. In addition to the re-cleanup of areas covered the previous year, the crews covered considerable new territory and it is believed that by far the largest part of the wild cotton growing areas of the keys and the mainland of that State have now been covered. It will be necessary to cover these locations annually for several years in order to destroy sprouts and seedlings.

Nurserymen who have applied for Federal pine shipping permits were engaged during April and May in the annual spring eradication of currant and gooseberry sprouts in the vicinity of their premises. By early in May, the work had been largely completed in Ohio, New York, and the New England States, and R. A. Sheals of the Bureau of Plant Quarantine checked on the completeness of the eradication work during that period. This was to be followed in June by similar checking in the Middle West by J. M. Corliss, and in the Pacific Northwest by C. R. Stillinger.

An infestation of an Egyptian oyster shell scale (*Lepidosaphes halli*) was discovered in the Plant Introduction Gardens at Chico, Calif., in February, and its complete eradication was immediately undertaken. The work was carried out under the direction of George G. Becker of the Division of Foreign Plant Quarantines representing the Federal Department of Agriculture, in cooperation with D. B. Mackie of the California State Department of Agriculture. About 500 trees were destroyed and others sprayed. While no specimens were found in the nursery stock growing in the gardens, all susceptible plants sent out from there during the current year are being collected and destroyed.

P. A. Glenn, Chief Plant Inspector of the Illinois Department of Agriculture, reports that the most important development in the work of his office that has come up lately is the rapid spread in the State of the European elm scale. It has become quite prevalent in four counties in the northeastern part of the State, in the vicinity of Springfield, Ill., and the western part of Champaign, Ill. It has gotten into the large nurseries in the northeastern part of the State in Chicago and is causing a great deal of extra work on the part of the nursery inspectors. At the present time the Department employs, besides the Chief Plant Inspector, 6 deputy nursery inspectors; 1 plant pathologist on watermelon wilt work, full time; 3 quarantine inspectors on European corn borer work, full time, and part time; 4 European corn borer scouts, part time, and 6 barberry scouts, part time.

The shipping season for Texas citrus fruit from the lower Rio Grande Valley under the Federal Mexican fruit fly quarantine, closed on April 5 and the host-free period required under the regulations began on April 6. Each year the State of Texas under the provisions of the Federal quarantine requires that all fruit susceptible to attack by the Mexican fruit fly be removed from the trees by the end of

the shipping season. The Bureau stated in making the announcement that it had originally been intended to permit the season to continue until April 30 but since Mexican fruit flies have been caught from time to time in traps on the Texas side of the border this spring, the Department found it necessary to institute the host-free period without delay. The order did not affect the shipment of fruit held in the valley in approved storage, such shipment continuing as long as the supply lasted.

Transit inspection activities for the spring of 1934 at St. Paul and at several Missouri Valley and Pacific Coast points were carried on throughout a greater part of May than usual, owing to the lateness of the shipping season this year. The northern nurseries reached the peak of retail shipments during the first half of that month instead of in April as usual. The amount of stock moving was also considerably greater than has been true for several years past. The rush of shipments resulted in a considerable number of instances in which the shippers failed to comply with Federal quarantine requirements and had their stock turned back as a result. The greatest number of interceptions reported for one day at one transit inspection point was at New York City, on May 1, when 19 violations of the gypsy moth and the Japanese beetle quarantines were intercepted.

"ECB" appearing on Federal certificates issued by the Bureau of Plant Quarantine has been the subject of recent inquiry on the part of State inspectors and others. This is an abbreviation for European corn borer, and when entered on a joint certificate of the bureau, i. e. one showing certification under two or more quarantines, it shows that the contents have been inspected and found free from the borer. For instance, "45, 48, ECB" appearing on the tag shows that the contents of the package have been inspected and found free from the gypsy moth (quarantine No. 45), the Japanese beetle (quarantine No. 48), and the European corn borer. The addition of "63" indicates that pines are authorized to be moved under the blister-rust quarantine, and of "63 Cont. Ar." that a control-area permit has been issued. When only quarantines 45 and 48 are the subject of certification, the inspector draws a line through the blank space following these figures on the tag, to show that no other authorization is involved.

Grapes from regions in foreign countries where the Mediterranean fruit fly occurs, which have been excluded from the United States by Federal plant quarantines since 1923, may now enter under permit and after sterilization at New York and such other northern points as may later be approved, under an order issued by the Bureau of Plant Quarantine on April 19 as circular BPQ–362. The announcement of the issuance of this order stated that the action was based "on the results of recent experiments by the Bureau of Entomology which demonstrated that all stages of the Mediterranean fruit fly in grapes can be destroyed by exposing the fruit to a reduced temperature for a certain period. The approved sterilization involves cooling the grapes until the center of the fruit reaches a temperature of 30 to 31 degrees F. and holding them at this temperature for 15 days. Storage tests on certain varieties of Vinifera grapes grown in the United States indicate that this sterilization does not injure the fruit if the prescribed temperature is carefully maintained."

DIRECTORY OF SUPPLIES AND EQUIPMENT USED AND RECOMMENDED BY ENTOMOLOGISTS

The following directory is compiled and published (1), for the convenience of entomologists in knowing where supplies and equipment ordinarily used in connection with research and control of insect pests can be obtained and subsequently recommended, and (2), for the convenience and financial aid to producers and sales agencies in bringing their products to the attention of those interested.

The publishers of the JOURNAL OF ECONOMIC ENTOMOLOGY believe the supplies and equipment listed in this Directory to be as represented by the manufacturers and sales agencies and recommend the use of this Directory whenever and wherever practicable.

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